GROWER PESTICIDE SAFETY COURSE

FIELD AND HORTICULTURAL CROPS

Manual prepared by:
Lisa Harwood
Susan Kelner

Ontario Pesticide Education Program
Ridgetown College of Agricultural Technology
Ridgetown, Ontario
N0P 2C0

Ministry of the Environment
ONTARIO
Jim Bradley, Minister

Ontario Agricultural Crop Protection Committee

Ministry of Agriculture and Food
ONTARIO
Jack Riddell, Minister

EMERGENCY NUMBERS

POISON INFORMATION CENTRES
Available 24 hours, 7 days a week

TORONTO
Hospital for Sick Children
555 University Avenue
M5G 1X8

Dr. M. McGuigan
Director

(416) 598-5900
1-800-268-9017

OTTAWA
Children's Hospital
of Eastern Ontario
401 Smyth Road
K1H 8L1

Dr. R. Peterson

(613) 521-4040
1-800-267-1373

SPILLS ACTION CENTRE (MINISTRY OF THE ENVIRONMENT)
1-800-268-6060
Call Regional Offices during office hours.

DANGEROUS GOODS EMERGENCIES
CANUTEC - Canadian Transport Emergency Centre, Transport Canada
(613) 996-6666 - Call collect

The staff provide advice on

- chemicals, physical and toxicological properties of dangerous goods
- health hazards and first aid
- fire explosion, spill or leak hazards
- remedial actions
- personal protective clothing

For **general information, CANUTEC** can be reached by calling **(613) 992-4624** in order to keep emergency lines free.

INFORMATION NUMBERS

PROVINCIAL REGULATORY OFFICE

(416) 323-5095

Agricultural and Industrial Chemical Section
Ontario Ministry of the Environment
135 St. Clair Avenue West, Suite 100
TORONTO
Ontario
M4V 1P5

ACCIDENTS, SPILLS (ENVIRONMENT CANADA)

(416) 973-1073

Regional Environmental Emergency Offices
Regional Environmental Emergency Co-ordinator
Environment Canada
7th Floor, Arthur Meighen Blvd.
25 St. Clair Avenue East
TORONTO
Ontario
M4T 1M2

AGRICULTURE CANADA PESTICIDE INFORMATION LINE

1-800-267-6315

Information is available on pesticides such as

- update of registered uses
- public concern issues
- general information

TRANSPORTATION OF DANGEROUS GOODS (MINISTRY OF TRANSPORTATION AND COMMUNICATIONS)

(416) 248-7450

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"Accidents in the Pesticide Storage"
"Vendor Storage"

LEGISLATION

SECTION 1

FEDERAL

Pesticides have been regulated in Canada since 1927 when Canada introduced the Agricultural Pest Control Act. In 1939, this Act was replaced by the Pest Control Products Act (PCP Act) which still exists today. The PCP Act was revised and its regulations came into force in 1972. It has been further amended to its present 1982 version. The Pest Control Products Act and Regulations regulate products used for the control of pests. Prior to sale or use in Canada, all pesticides must be registered under the PCP Act.

PEST CONTROL PRODUCTS ACT

Under the Pest Control Products Act, a pesticide is defined as:

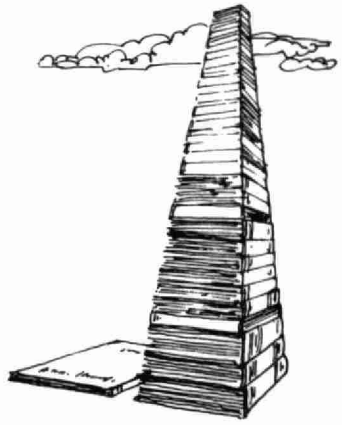
> any product, device, organism, substance or thing that is manufactured, represented, sold or used as a means for directly or indirectly controlling, preventing, destroying, mitigating, attracting or repelling any pest, and includes
>
> * any compound or substance that enhances or modifies or is intended to enhance or modify the physical or chemical characteristics of a control product to which it is added, and
> * any active ingredient used for the manufacture of a control product;

The PCP Act and Regulations are administered by Agriculture Canada in consultation with one or more of the following departments:

> Health and Welfare Canada
> Environment Canada
> Fisheries and Oceans Canada

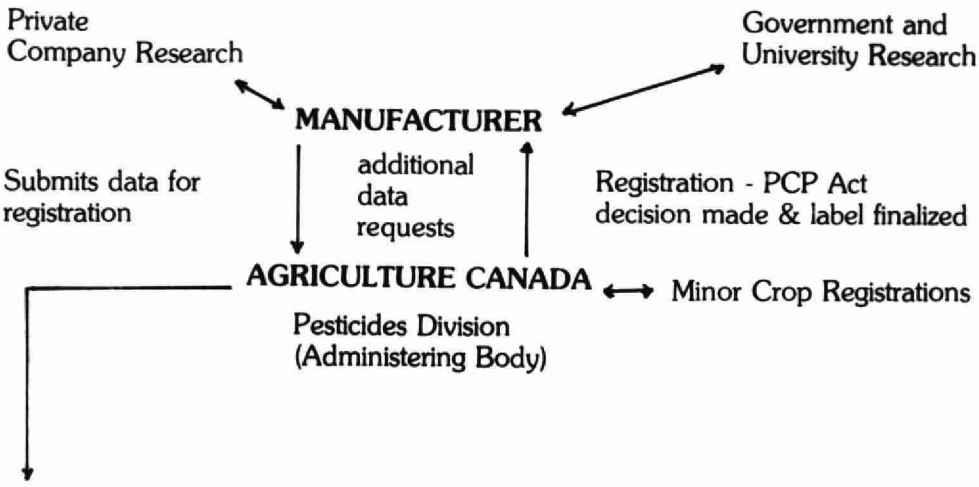
Before a pesticide is registered, the manufacturer must prove that it is safe and effective when used as directed on the label. To support registration, the manufacturer submits scientific data on product chemistry, toxicology, metabolism, residues, environmental impact and efficacy. Agriculture Canada co-ordinates the review of these data, requesting experts from the other departments to review appropriate portions. Although Agriculture Canada relies on these experts, the ultimate decision concerning registration lies with Agriculture Canada.

Re-evaluation of existing registered pesticides may be carried out by Agriculture Canada when new information becomes available or a new use is requested to be added to the label. Within the past ten years, data requirements have changed and technology has advanced, making new information available concerning effectiveness and safety of pesticides to the operator and the environment. Products are reviewed in consideration of the current data and decisions may be made to delete a use, redefine a use, include additional precautions or even suspend or cancel a product. When a product is suspended, any product already at retail outlets may be sold, but the registrant may not ship any more product. In comparison, cancellation does not allow the product, already at retail outlets, to be sold. In some cases, the product may even be recalled. The registrant may appeal any decision and present their case in support of continued registration or the registrant may choose to voluntarily remove the product. Provision for re-evaluation is made in the regulations by the statement that the Minister must be satisfied "that the availability of the control product will not lead to an unacceptable risk of harm to things on or in relation to which the control product is intended to be used or public health, plants, animals or environment" (Sec. 19).



A lot of information is needed before a product is registered.

APPLICATION FOR REGISTRATION OF A PESTICIDE



EXPERT REVIEWERS
Health and Welfare Canada
- Food Directorate (residues)
- Environmental Health Directorate (exposure)

Environment Canada
- Canada Wildlife Service
- Environment Protection Service (environmental contamination)

Fisheries and Oceans Canada

Agriculture Canada
- Laboratory Services (chemistry)
- Canadian Forestry Service
- Canadian Grain Commission (residues in grains and oil seeds)
- Research Branch (efficacy)

OTHER FEDERAL ACTS

There are other federal acts which regulate pesticides:
National Health and Welfare Act
Food and Drugs Act
Pesticide Residues Compensation Act
Feeds Act
Environmental Contaminants Act
Fisheries Act
Migratory Birds Convention Act
Transportation of Dangerous Goods Act

National Health & Welfare Act
Health and Welfare Canada is responsible for assessing the risk associated with occupational exposure to agricultural chemicals. The Environmental Health Directorate evaluates the hazard of a pesticide by reviewing the toxicological studies and field exposure studies to determine a margin of safety (MOS). The user sees the result of this review in the precautionary statements and the hazard symbol on the label.

Food & Drugs Act and Regulations
The Food and Drugs Act, administered by the Food Directorate of Health and Welfare Canada protects the health of consumers by prohibiting the sale of food that contains any harmful or poisonous substance. Under the authority of the Act,

the Food Directorate determines the residue tolerances of pesticides in foods. Assuming that the product will be applied using good agricultural practice, the Food Directorate establishes a maximum residue limit (MRL) expressed in parts per million based on the toxicity of the pesticide, its application rate and timing, and the crop to which it is being applied. Their decision is reflected on the label in the pre-harvest statements such as, "Do not apply within 10 days of harvest".

Also, any restrictions regarding the grazing or feeding of crop refuse to livestock are determined by the Food Directorate and these statements are put on the label. The responsibility lies with the primary producer, sprayer operator, and food processor to ensure that the restrictions are met. Contravention could result in the crop or produce being seized and fines or jail sentences applied.

Pesticide Residues Compensation Act
This Act compensates the producer for damages or losses incurred when the sale of produce is stopped due to the presence of pesticide residues greater than the limit imposed by the Food and Drugs Act. It must be proven that the residues exist through no fault of the producer and that the pesticide was applied according to the label directions as registered.

Feeds Act
The Feeds Act regulates the contamination of feed.

Environmental Contaminants Act
Administered by Environment Canada and Health and Welfare Canada, the Act controls substances which have the potential to contaminate the environment. The Environmental Contaminants Act would be used in cases where the PCP Act does not have adequate power.

Fisheries Act
The Fisheries Act protects fish from the placement of harmful substances in water frequented by fish.

Migratory Birds Convention Act
The Migratory Birds Convention Act protects waterfowl and migratory birds from the placement of harmful substances in water or any area frequented by migratory birds.

Transportation of Dangerous Goods Act
Transport Canada administers this Act which controls the handling, offering for transport, and transport of hazardous products including pesticides. In Ontario, the Ministry of Transportation and Communications enforces this Act with respect to the transportation on roads only.

PROVINCIAL

THE PESTICIDES ACT AND REGULATION

In Ontario, pesticides are regulated by the Pesticides Act and Regulation administered by the Ministry of the Environment. In the Act the terms "pest" and "pesticide" are defined as follows:

"pest" means any injurious, noxious or troublesome plant or animal life other than man or plant or animal life on or in man and includes any injurious, noxious or troublesome organic function of a plant or animal;

"pesticide" means any organism, substance or thing that is manufactured, represented, sold or used as a means of directly or indirectly controlling, preventing, destroying, mitigating, attracting or repelling any pest or of altering the growth, development or characteristics of any plant life that is not a pest and includes an organism, substance or thing registered under the Pest Control Products Act (Canada);

Under the Act, all pesticides registered under the PCP Act must be classified in Ontario before being offered for sale. Products are classified into one of six schedules depending on their toxicity, environmental or health hazards, persistence, concentration and use. The classification system allows Ontario to restrict access of pesticides to persons who clearly need them and have the knowledge to use them properly. The review of the technical data supporting classification is carried out by the Ontario Pesticides Advisory Committee who, in turn, makes recommendations to the Minister for approval.

The following summarizes the schedules used in the classification system.

EXPLANATION OF SCHEDULES

SCHEDULE	USERS
1	Restricted. Use Permit Only.
2,5	Restricted to Agriculturalists, Custom Sprayers, Exterminators.
3	Available to Agriculturalists, Custom Sprayers, Exterminators. Some may be available to general public.
4	Domestic classed products only. (◄ 1 kg, ◄ 1 L)
6	Similar to 4 but sold commercially. (► 1 kg, ► 1 L)

The Pesticides Act and Regulation regulates use, storage, display, disposal and transportation of pesticides. These regulations are explained in their specific manual sections.

OTHER PROVINCIAL ACTS

There are other Acts in Ontario which regulate the use of pesticides:
- The Environmental Protection Act
- The Weed Control Act
- The Occupational Health & Safety Act

The Environmental Protection Act

The purpose of the Environmental Protection Act is to provide for the protection and conservation of the natural environment. This Act, administered by the Ministry of the Environment, would apply to pesticides if they were considered to be contaminants of the natural environment.

Part IX of the ENVIRONMENTAL PROTECTION ACT regulates spills of pollutants, and is more commonly known as the "Spills Bill". The "Spills Bill" came into force November 29, 1985.

Under this part of the Environmental Protection Act, any person who spills or causes or permits a spill of a pollutant must:

1. REPORT the spill to the Spills Action Centre (1-800-268-6060) if there is any possibility that the spill is likely to cause adverse effects.

2. CLEAN UP the spill. After reporting the spill, the Spills Action Centre will give advice on how to deal with the spill.

The onus is on the person to assess the situation and take responsibility for the spill. If the farmer becomes liable for a spill, the "Spills Bill" limits the farmer's liability to one-half million dollars ($500,000).

If the farmer is the victim of a spill, which is more often the case, under the Act the farmer is entitled to compensation from the owner of the spilled material or the person who had control of the material immediately prior to the spill.

The Weed Control Act (1974)

In Ontario, 23 weeds are classed as noxious under the Weed Control Act. This Act states that "Every person in possession of land shall destroy all noxious weeds thereon".

Weeds are classed as noxious for several reasons. Some are noxious because they can cause injury to people (poison-ivy causes severe rash; pollen from the ragweeds causes hay fever); some because they increase crop diseases (Common barberry is the alternate host for organisms which cause stem rust in oats, barley, rye and spring wheat; European buckthorn is the alternate host for organisms causing leaf rust and crown rust of oats); others because they reduce crop yield and either are very difficult to control (leafy spurge, tuberous vetchling), or have seeds that blow on the wind (Canada thistle, sow-thistle). Copies of the Weed Control Act may be obtained from the Soils and Crops Branch, Ontario Ministry of Agriculture and Food, Toronto, Ontario.

The weeds named below are classified as noxious in Ontario under the Weed Control Act:

Common Name	Scientific Name
Bull thistle	**Cirsium vulgare** (Savi) Tenore
Canada thistle	**Cirsium arvense** (L.) Scop.
Chicory	**Cichorium intybus** L.
Common barberry	**Berberis vulgaris** L.
European buckthorn	**Rhamnus cathartica** L.
Dodder	**Cuscuta** spp.
Field bindweed	**Convolvulus arvensis** L.
Goat's-beard	**Tragopogon** spp.
Johnson grass	**Sorghum halespense** (L.) Pers.
Milkweed	**Asclepias** spp.
Nodding thistle	**Carduus** spp.
Poison-ivy	**Rhus radicans** L.
Ragweed	**Ambrosia** spp.
Russian knapweed	**Centaurea repens** L.
Russian thistle	**Salsola pestifer** A. Nels.
Scotch thistle	**Onopordum acanthium** L.
Sow-thistle, perennial, annual	**Sonchus** spp.
Cypress spurge	**Euphorbia cyparissias** L.
Leafy spurge	**Euphorbia esula** L.
Tuberous vetchling	**Lathyrus tuberosus** L.
Wild carrot	**Daucus carota** L.
Wild garlic	**Allium vineale** L.
Yellow rocket	**Barbarea** spp.

The Occupational Health and Safety Act

The Occupational Health and Safety Act is designed to protect workers against health and safety hazards in the workplace. The Act applies to all workplaces except private homes and farming operations. It would apply to any workplace manufacturing or handling pesticide products. The Act is administered by the Ministry of Labour under the Occupational Health and Safety Division.

PESTICIDE TOXICITY

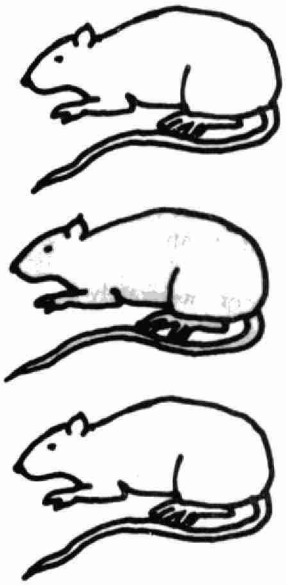
GENERAL DEFINITIONS

Pesticides vary in their toxicity, from being only slightly toxic to being extremely toxic. Toxicity is the degree to which a substance is harmful or poisonous.

Acute Toxicity of a pesticide refers to the toxic response resulting from a single dose of, or exposure to a pesticide.

Chronic Toxicity is the toxic response resulting from repeated exposures to small doses of a pesticide over a longer period of time.

Scientists measure the toxicity of a pesticide by determining its LD_{50}.



Lethal Dose 50% (LD_{50})
The LD_{50} value is the statistical estimate of a chemical dose which when administered will kill 50% of the test animals within a stated period of observation (24 hours to seven days). The LD_{50} value is commonly expressed as milligrams of a substance per kilogram of body weight of the test animal. The test animal is usually a rat, mouse or rabbit. The larger the value, the less toxic the pesticide. Pesticides with low values (0-10) are extremely toxic.

Examples:

Pesticide	Acute Oral LD_{50} mg/kg
2, 4-D	550
malathion	1,375
atrazine	3,080

It may be useful to compare the LD_{50} of certain pesticides with the LD_{50} of substances commonly used by people in their homes. The following three compounds have a low acute toxicity in terms of the rating for pesticides, but could cause toxic reactions if consumed in sufficient quantities.

Compound	Oral LD_{50} (mg/kg)
acetylsalicylic acid (Aspirin)	1,000
sodium chloride (table salt)	3,320
ethylene glycol (antifreeze)	3,460

Acute Oral LD_{50} is the amount of a substance (mg/kg of body weight) which when ingested orally will kill 50% of the test animals.

Dermal LD_{50} is the amount of a substance (mg/kg of body weight) which when applied to the skin will kill 50% of the test animals.

Inhalation Toxicity LC_{50} is the concentration (expressed in parts per million) of a substance in air which will kill 50% of the test animals over a predetermined period of time.

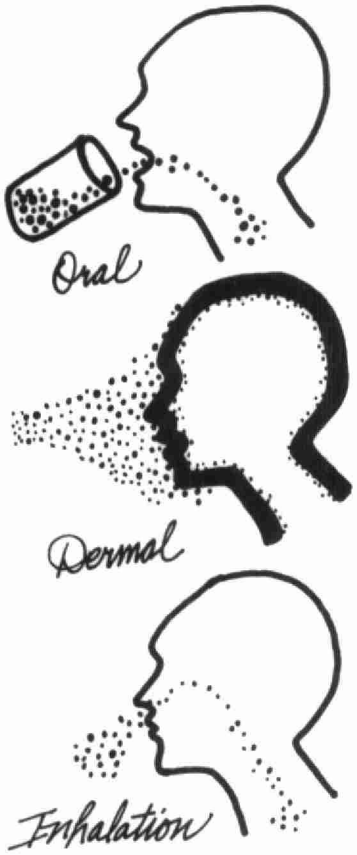
HAZARD AND RISK

The "hazard" and "risk" of pesticides should be of concern to users. Hazard is the danger of exposure to the pesticide. Risk is the magnitude of harm resulting from exposure and the possibility of it occurring.

RISK = TOXICITY x EXPOSURE

A highly toxic pesticide can be used without causing a harmful effect if it is handled with care and with caution. Exposure to pesticides can be minimized by wearing protective clothing and equipment, and by learning how to handle pesticides carefully. If the exposure to the pesticide is low or even nil, then the risk is reduced, even when handling highly toxic pesticides.

ROUTES OF ABSORPTION OF PESTICIDES



Oral refers to the intake of a substance by the mouth and digestive tract. Poisoning may result from accidental ingestion, ingestion for suicidal reasons or contamination of food stuffs. It is commonly due to carelessness, for example blowing out of sprayer nozzles or smoking or eating prior to washing the hands. The most common occurrences of oral intake is when pesticides have been removed from their original containers and stored in liquor, soft drink or food bottles.

Dermal is the intake of a substance through contact with exposed skin. It can occur easily through direct contact with the spray concentrate, spray solution or spray mist during spraying or through the wearing of contaminated clothing. Absorption depends on several conditions. Skin rashes, broken skin or abrasions may increase the rate of absorption. There is less absorption of powders than liquids. Oil solutions may be more readily absorbed than water solutions. Although intact skin is a very effective barrier against many substances, dermal absorption is the most common route of poisoning from the exposure to pesticides.

Inhalation is the absorption of airborne particles of a substance. It occurs when mixing and spraying and is increased when working in confined or poorly ventilated areas. The chemical must be airborne to cause exposure and this is achieved by the production of small spray particles, gases or vapours. The nose and throat are very effective barriers and only very small particles can reach the lung. The surface of the lung is a very fine membrance which is a poor barrier against the entry of chemicals. The membrane may also be damaged by some chemical reducing its effectiveness.

TYPES OF CHRONIC TOXICITY

It is not possible to assess chronic toxicity of a pesticide in the same way as an LD_{50} or LC_{50} is used to determine acute toxicity. Instead, a number of different tests are performed on animals which help to predict whether a pesticide will cause a number of possible long-term effects. Test animals are exposed to sublethal levels of pesticides for periods ranging from about 90 days to several years. They are examined for a wide variety of toxic effects from dermal, oral and respiratory exposure. Such effects include:

Mutagenicity is a mutation or genetic change in a cell. It may occur in the germ cell (sperm or ovum) of a parent, in the cell formed by the union of sperm and ovum from which the fetus develops or in some cell(s) of the fetus after development has begun.

Carcinogenicity is the production of cancer i.e. new or abnormal growth such as a tumour. All chemicals which produce cancer are carcinogens.

Teratogenicity is the production of abnormalities (malformation in developing organisms such as the fetus). Thalidomide is one of the better known teratogens.

PESTICIDE POISONINGS

All pesticides are poisons. They are designed to control or kill specific pests, whether those pests are weeds, insects, fungi or rodents. Hence, at some dose level, they will affect humans too. Some pesticides are more poisonous than others and a small dose will produce harmful effects. Other pesticides are less toxic and a larger dose is necessary to cause an effect. But, no matter how toxic, all pesticides are poisonous. It is important for the user to take precautions to prevent being exposed to a pesticide.

POISONING STATISTICS

Health and Welfare Canada collects data on the number of poisonings reported each year in Canada. This data is further divided into those poisonings occurring by pesticides and by province. The following table shows the number of reported pesticide poisonings in Ontario and Canada in 1985. The data collection process is not so defined as to separate rural and urban areas, so that the number of poisonings occurring on farms is unknown. However, the data does show that pesticide poisonings do occur. In Canada, 3,485 poisonings were reported to be caused by pesticides, 1,411 poisonings being reported in Ontario. Of the total number of poisonings reported, over half of them happened to children under the age of four.

From the data in the table, it appears that the majority of the poisonings in Canada occur in Ontario. However this may be a result of Ontario's better data collection program. Statistics available on pesticide poisonings are limited and poorly defined by area and product use. Therefore, these statistics could be under estimating the number of poisonings caused by pesticides. Whether under estimated or not, one thousand four hundred and eleven pesticide poisonings were reported in Ontario in 1985, and this should be enough to cause concern.

PESTICIDE POISIONING CASES, 1985

	AGE GROUP IN YEARS				PHONE CALLS	TREATED OR HOSPITALIZED				DEATH (15+)		
	TOTAL*	0-4	4-15	15+		TOTAL*	0-4	4-15	15+	TOTAL*	ACDT.	SUIC.
ONTARIO	1411	870	106	168	825	586	241	40	123	6	1	5
CANADA	3485	2111	275	645	2069	1386	784	99	285	8	1	7

*Total includes unspecified cases

Source: Health & Welfare Canada

HOW DO ACCIDENTAL POISONINGS OCCUR

Pesticides can enter the body in four ways:

- through the skin (dermal exposure)
- through the mouth (oral exposure)
- through the lungs (inhalation exposure)
- through the eyes (ocular exposure)

A user can be poisoned, not realizing that the pesticide has entered his body.

THROUGH THE SKIN

Poisonings can occur from pesticides entering the body through contact with the skin. Many studies show that 95% of a person's exposure is through the skin or uptake of a pesticide through the skin. Absorption depends on the condition of the skin, the part of the body contacted and the pesticide itself.

If the skin has cuts, scrapes or abrasions, absorption will be increased. Absorption will also be increased if the skin is moist and sweaty. The part of the body that the pesticide contacts also makes a difference to the rate of absorption. Different parts of the body have different degrees of absorption.

Body Part	Absorption
Eye	100%
Scrotal Area	100%
Ear Canal	47%
Scalp	32%
Abdomen	19%
Foot	14%
Palm of Hand	12%
Forearm	8.6%

Formulation type will also affect the skin's absorption of pesticides. Some formulations such as emulsifiable concentrates (E.C.) may contain solvents which help the pesticide enter the body. Granular (G) formulations may be less readily absorbed provided proper care is exercised when handling the pesticide.

Remember

- Wear protective clothing and equipment when using pesticides.
- Wear protective clothing and equipment when repairing equipment contaminated with pesticides.
- Wash and shower after using pesticides.
- Wash before eating, drinking or smoking.
- Change clothing and shower immediately when a pesticide spills on your body.
- Spray so that the winds carry the pesticide away from you.
- Do not re-enter a sprayed field until the specified re-entry time has elasped.
- Wash clothing used during pesticide application separate from other laundry on a daily basis.

THROUGH THE MOUTH

Poisonings can occur from pesticides entering the body through the mouth. Most often this happens when a person mistakenly drinks a pesticide from an unlabelled container or consumes recently treated produce. Because absorption is rapid through the stomach and the intestines, poisoning can be severe and serious illness may result.

Remember

- Store pesticides in their original container away from children or unauthorized persons.
- Wash after handling pesticides and before eating, drinking or smoking.
- Do not use the mouth to siphon pesticide liquids or clean sprayer nozzles.
- Avoid splashes or dusts when mixing concentrates.

THROUGH THE LUNGS

Poisonings can occur from pesticides entering the body through the lungs. Once in the lungs, absorption is almost complete. Most particulates and spray droplets are too large to enter the lungs directly, but they can accumulate in the nasal passages and eventually enter the body from the swallowing of saliva. Small spray droplets present a greater hazard than larger droplets since they are easier to inhale. When applying fumigants, inhalation can be the main route of absorption.

Remember

- Wear appropriate and properly fitting respirator or mask when necessary.
- Do not smoke during application and do not use contaminated smoking supplies.
- Do not re-enter a treated area or room too soon.

THROUGH THE EYES

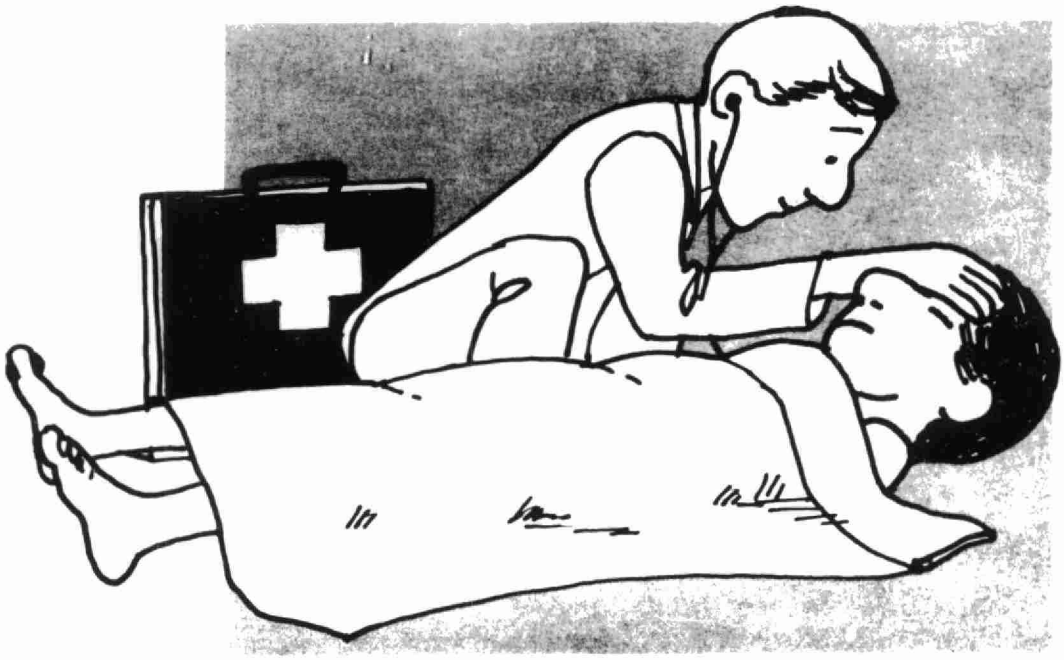
Poisonings can occur from pesticides entering the body through the eyes. Although a small part of the total skin area, absorption is 100% through the eyes. Some pesticides cause eye irritation and even severe damage if they contact the eyes.

Remember

- Pesticides can be splashed into the eyes very easily when mixing and loading.
- Wear goggles during such operations.

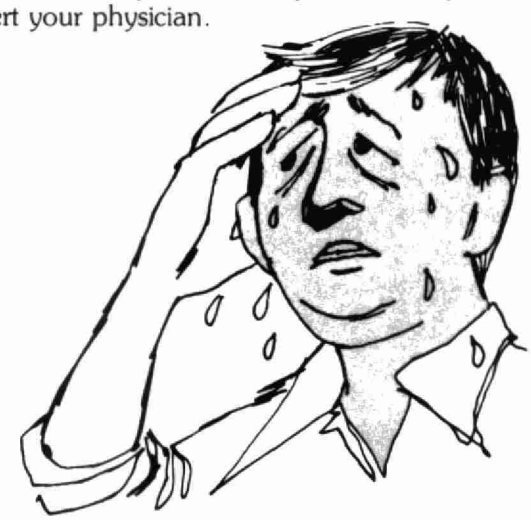
LEARN THE SYMPTOMS OF POISONING

Learn to recognize the symptoms of pesticide poisoning. Quick action may prevent additional exposure and minimize injury. Early recognition may save a life.



Symptoms will vary with the pesticide, the exposure and the individual. Also, the symptoms of pesticide poisoning may be confused with the symptoms of food poisoning, asthma, flu and other illnesses. So, be aware that your symptoms

could be a result of exposure to a pesticide. If you have been exposed to a pesticide, alert your physician.



Mild Symptoms: Headache, fatigue, loss of appetite, dizziness, weakness, nervousness, nausea, perspiration, diarrhea, loss of weight, thirst, moodiness, and irritation of skin, eye, nose and throat.

Moderate Symptoms: Nausea, trembling, muscular inco-ordination, excessive salivation, blurred vision, constricted throat or chest, laboured breathing, flushed or yellow skin, abdominal cramps, vomiting, diarrhea, mental confusion, perspiration, rapid pulse and cough.

Severe Symptoms: Vomiting, loss of reflexes, inability to breathe, muscle twitching, constricted pupils, convulsions, unconsciousness, thirst, fever and increased respiration rate.

PESTICIDE SENSITIZATION AND ALLERGIC RESPONSES

Some people are more sensitive to certain pesticides than others. One person may develop symptoms from a pesticide while a fellow worker remains unaffected. Quite often the symptoms are skin rashes. The sensitization may not occur immediately. A visible reaction may not occur the first time a person is exposed, but months later when that same person is exposed again.

Another unique allergic reaction is photo-allergic dermatitis. Some pesticides, when used in excess sunlight, cause dermatitis. Examples of pesticides causing this effect include formulations of zineb, atrazine and thiram.

ACUTE AND CHRONIC POISONING

There are two kinds of poisonings, acute and chronic. Acute poisoning occurs from a single dose with the symptoms usually being severe and immediate. In comparison, chronic poisoning occurs when a person is exposed to many non-poisonous doses of pesticide over an extended period of time. Symptoms appear when a sufficient amount of the pesticide builds up in the body. No matter how the poisoning occurs, the person has received a large enough pesticide dose to cause poisoning symptoms.

To identify poisoning symptoms and to properly react to them, it helps to know about the pesticide and its chemical family. All pesticides in the same chemical family cause the same kind of sickness.

CHEMICAL FAMILIES

Three chemical families are often the cause of pesticide poisonings:
1) organochlorine insecticides (CHI)
2) organophosphorus insecticides (OPI)
3) carbamates (C)

Organochlorine Insecticides (CHI)
Examples of these pesticides are methoxychlor, endosulfan (THIODAN) and lindane. Poisoning results from continuous exposure to small doses over a period of time. These pesticides accumulate in the fatty tissue of the body and depending on the dose, duration and frequency of exposure, chronic poisoning can occur. Organochlorines act to destabilize the nervous system but how this occurs is unknown.

Organophosphorus Insecticides (OPI)
The organophosphorus insecticide (OPI) family contains some of the most toxic pesticides. Absorption readily occurs through the skin, lungs and digestive track. Examples of these pesticides include azinphos-methyl (GUTHION), fonofos (DYFONATE) parathion, chlorpyrifos (LORSBAN) and diazinon. Acute poisoning is the most likely type of poisoning to occur since OPI's do not accumulate readily in the body over a period of time. The severity of the condition is dependent on the rate that the pesticide is broken down in the body. If broken down quickly, the pesticide's availability to affect the nervous system is limited. OPI's affect the nervous system by eventually reducing the cholinesterase level in the blood to the point where poisoning occurs (see section on cholinesterase levels). To return the cholinesterase to a normal level, the victim should be removed and kept from the source of pesticide exposure. Generally, long term effects are minimal unless the exposure is continuous. Continuous exposure is unlikely to occur in normal farming operations but may occur in improperly ventilated storage areas.

Carbamate Insecticides (C)
Carbamates have moderately low to high toxicities. An example of a moderately toxic carbamate is carbaryl (SEVIN). Also in this group are aldicarb (TEMIK), methomyl (LANNATE) and carbofuran (FURADAN), which have higher toxicities. As with the organophosphorus insecticides, carbamates affect the cholinesterase level in the blood. The cholinesterase level recovers more rapidly with the carbamates than with the organophosphorus insecticides, so any effects from carbamate exposure are short-lived compared to exposure to organophosphorus insecticides.

Others
Certain other pesticides have high acute toxicities. These include dinitrophenols, bipyridyliums and fumigants.

Dinitrophenols include herbicides, insecticides and fungicides. Examples are dinoseb, (DNBP), dinocap (KARATHANE) and DNC, an insecticide. These pesticides are most toxic when swallowed, but can be absorbed through the lungs and skin. Once absorbed they speed up many body processes causing symptoms such as fever, sweating, rapid breathing and rapid heartbeat. A single large dose can cause immediate severe symptoms. Chronic poisoning can also occur.

Bipyridyliums include the herbicides diquat (REGLONE) and paraquat (GRAMOXONE). These products can be fatal if swallowed, inhaled or absorbed through the skin. Paraquat may cause lung fibrosis if taken in by the mouth or inhaled.

Fumigants are extremely toxic. Because of their method of application, they are extremely hazardous. Methyl bromide can cause severe chemical burns on the skin, chemical pneumonia and severe kidney damage. Any of these symptoms are fatal. If smaller amounts are inhaled, symptoms could be double vision, slurred speech and lack of co-ordination, giving the appearance of alcoholic intoxication. Chloropicrin is very irritating to the eyes. Unlike methyl bromide, it has an odour and is sometimes added to methyl bromide as a warning agent. Carbon tetrachloride affects the nerves and severely damages the cells of the kidney and liver.

The hazard of pesticides, if handled in a proper manner, can be reduced. Since many pesticides can be handled in large amounts quite frequently without resulting in acute poisoning symptoms, the user is given a false feeling of safety. Not all long term effects are known and care and precaution should be used when handling any pesticide.

CHOLINESTERASE LEVEL

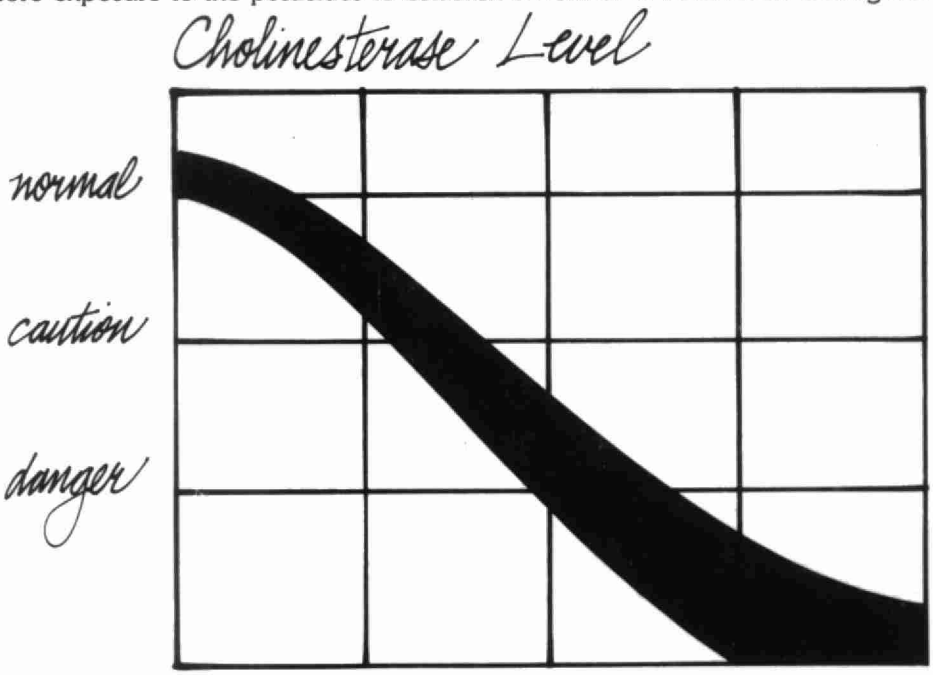
Organophosphorus insecticides and carbamates affect the nervous system by inhibiting the enzyme, acetyl cholinesterase. The nervous system transmits messages from the brain to various parts of the body. Carbamates and OPI's affect the transmission of these signals.

To transmit a message, a signal must pass from one nerve fibre to another over a gap called a synapse. To transmit the message across the synapse, a chemical, acetylcholine, is released at one nerve ending to stimulate the next nerve ending. Once the message has been received by the second nerve ending, the message is stopped by an enzyme called acetyl cholinesterase. Acetyl cholinesterase breaks down the acetylcholine into acetyl and choline. If acetylcholine is not broken down, the message continues to be sent to the muscles. If organophosphorus insecticides and carbamates are in the body they bind with the acetyl cholinesterase and prevent the enzyme from breaking down the acetylcholine. The message continues to be sent across the synapse. This causes the muscles to twitch constantly and can result in the person having fits or convulsions.

With the organophosphorus insecticides, the bonding with acetyl cholinesterase is strong and is described as being "irreversible". In comparison, the bonding with the carbamates is weaker and considered "reversible". But, in both cases, if the person is treated promptly by being removed from the source of exposure and having the antidote, ATROPINE, administered by a physician, the level of cholinesterase will return to pre-exposure levels. The person should be kept from exposure until the cholinesterase level returns to normal. A blood test can be done to monitor the level of cholinesterase.

CHOLINESTERASE BLOOD TEST

Persons regularly handling or apply OPI's or carbamates should obtain cholinesterase blood tests. In order to be able to use this test, a test is required before exposure to the pesticides to establish a normal or base level. During the



spray season, when a person may be spraying OPI's or carbamates regularly for several weeks, a test should be taken every seven to ten days. A test should also be taken after exposure is completed. This can be decided between you and your physician. When tested, if the cholinesterase level is below 50% of the base level, the person should be removed from exposure until the level has returned to normal.

Most chemical companies using or manufacturing OPI and carbamates require their employees to have regular blood tests. It is a routine procedure which is just one part of a company's complete safety program. A test will help the physician diagnose a poisoning, alert him to a possible poisoning, and warn the operator that he has not used enough safety precautions when working with these types of pesticides. A test can be arranged with a physician.

RECOGNITION OF SYMPTOMS

The following chart lists some major groups of pesticides. Identifying the chemical group of the pesticide aids in the recognition of poisoning symptoms.

THE RECOGNITION OF POISONING SYMPTOMS

GROUP	EXAMPLES	MODE OF ACTION	SYMPTOMS	CHRONIC SYMPTOMS	PESTICIDE USE
Amides	metolachlor (DUAL) CDAA (RANDOX)	Irritants	Moderately irritating to skin and eyes.		Herbicides
Bipyridyliums	diquat (REGLONE) paraquat (GRAMOXONE)	Injure skin, nails, cornea, liver, kidney, linings of stomach and intestine, and and respiratory system (paraquat only)	Burning pain, nausea, vomiting, and diarrhea. Irritates and injures skin and nails.		Herbicides
Carbamates	aldicarb (TEMIK) carbaryl (SEVIN) carbofuran (FURADAN) methomyl (LANNATE)	"Reversible" changes in acetyl cholinesterase enzyme of blood.	Headache, dizziness, weakness, shaking, nausea, stomach cramps, diarrhea, sweating. Minimal rashes but readily absorbed through the skin.	Loss of appetite, weakness, weight loss, and general feeling of sickness.	Insecticides, acaricides.
Dinitroaniline	trifluralin (TREFLAN)	Irritant	Slightly to moderately irritating to skin, eyes, nose and throat.		Herbicides
Organochlorines (Chlorinated Hydrocarbons)	lindane methoxychlor endosulfan	Disrupt function of nervous system, mainly the brain.	Headache, dizziness, weakness, shaking, nausea, excitability, disorientation. Minimal rashes but readily absorbed through the skin.	Some build up in the fat tissues. May cause nervousness, weakness and shaking.	Insecticides, acaricides.
Organophosphorus	chlorpyrifos (LORSBAN) dimethoate (CYGON) azinphos-methyl (GUTHION) malathion diazinon terbufos (COUNTER)	Inhibits, acetyl-cholinesterase (an enzyme) in the blood. "irreversible"	Headache, dizziness, weakness, shaking, nausea, stomach cramps, diarrhea, sweating. Minimal rashes but readily absorbed through the skin.	Loss of appetite, weakness, weight loss, and general feeling of sickness.	Insecticides, acaricides.

GROUP	EXAMPLES	MODE OF ACTION	SYMPTOMS	CHRONIC SYMPTOMS	PESTICIDE USE
Phenoxys	2,4-D 2,4-DB (EMBUTOX) MCPB (TROPOTOX) mecoprop	Irritant to lung, stomach and intestinal linings. Injure liver, kidney and nervous system.	Prompt vomiting, burning sensation in stomach, diarrhea, muscle twitching. Moderately irritating to eyes, skin, and lungs.	Do not remain in body; passed out within hours or days.	Herbicides
Pyrethrins/ Pyrethroids	fenvalerate (BELMARK) cypermethrin (CYMBUSH) permethrin (AMBUSH) deltamethrin (DECIS)	Very low human toxicity.	Slight toxic reaction.		Insecticides
Thiocarbamates/ Dithiocarbamates	butylate (SUTAN +) EPTC (EPTAM, ERADICANE)	Low human toxicity.	Nausea, vomiting, diarrhea, weakness, and nasal stuffiness. Irritating to skin, eyes, nose, and throat.		Herbicides
Triazines	metribuzin (LEXONE, SENCOR) cyanazine (BLADEX) atrazine (AATREX) simazine (PRINCEP)	Irritant	Mildly irritating to skin, eyes, nose, and throat.		Herbicides
Uracils	bromacil (HYVAR) terbacil (SINBAR)	Irritant	Irritating to lungs, skin, eyes, nose and throat.		Herbicides
Ureas	linuron (LOROX, AFOLAN) diuron (KARMEX) tebuthiuron (SPIKE) metobromuron (PATORAN) monolinuron (AFESIN)	Irritant	Moderately irritating to skin, eyes, nose and throat.		Herbicides
	gylphosate (ROUNDUP)	Irritant	Irritates lungs and eyes.		Herbicides

FIRST AID

FIRST AID

EMERGENCY ACTION

In spite of all precautions, pesticide accidents can still happen.

Be able to recognize poisoning symptoms and know what actions to take before a pesticide poisoning occurs. Early recognition of the poisoning symptoms and prompt action may save a life.

Be prepared to act quickly, calmly, and intelligently when an accident does happen.

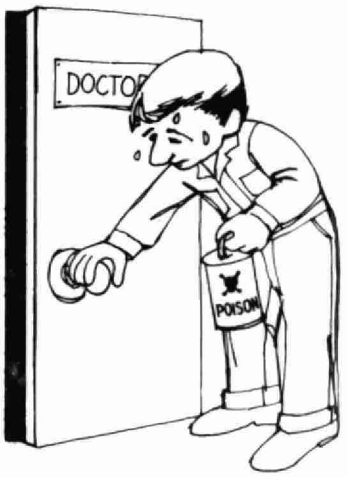
Immediately call a doctor or an ambulance!

Exception: if alone with the victim, first proceed as follows, then call the doctor.

FIRST AID TREATMENT:

GENERAL FIRST AID

- Stop the exposure. Move patient away from contaminated area. Remove any contaminated clothing and wash exposed area with soap and water. Wear protective equipment before entering the contaminated area.
- Start first-aid treatment immediately. Refer to pesticide label. If victim is not breathing, give A.R. (artifical respiration).
- Get medical help. Call the Poison Information Centre. If medical help cannot be obtained or is delayed, transport the victim to the nearest hospital or physician's office.
- Save the pesticide container and any material in it. Get a readable label for the medical personnel.
- Keep victim at rest, warm and comfortable. Continue first aid treatment. Do not leave a critically ill patient alone.



IF PESTICIDE CONTACTS EYES

- Hold eyelids open and wash with large amounts of clean running water for fifteen minutes or more.
- Get medical attention.

IF PESTICIDE CONTACTS SKIN

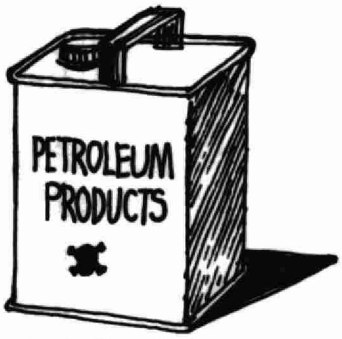
- Remove contaminated clothing.
- Drench skin with water.
- Wash skin, hair and nails thoroughly with plenty of soap and water. Repeat.
- Dry victim and wrap in blanket or clean clothes.
- Get medical attention.

FOR CHEMICAL BURNS ON SKIN

- Remove contaminated clothing.
- Wash with large amounts of water.
- Cover with a loosely applied clean cloth.
- Treat shock (keep patient flat, with feet raised, and warm).
- Avoid the use of ointments, greases, powders and other drugs.
- Get medical attention.

IF INHALED (dusts, vapours, gases)

- Remove victim from contaminated area. (Do not rescue unless wearing protective equipment).
- Carry victim to fresh air.
- Loosen tight clothing.
- Give A.R. Maintain breathing.
- Get medical attention.



Do NOT induce vomiting!

IF SWALLOWED

- Call physician immediately and induce vomiting **except when**
  - patient is in a coma or is unconscious
  - patient is in convulsions
  - patient has swallowed petroleum products
  - patient has swallowed a corrosive poison (strong acid/alkaline products).

TO INDUCE VOMITING. Give syrup of ipecac - 15 ml. (1 tablespoon) to children, 30 ml. (2 tablespoons) to adults. Follow with one to two glasses of water, milk or fruit juice. Repeat in fifteen minutes if vomiting has not occurred. Ipecac can be purchased at a local drug store. It is the only sure way to induce vomiting.

Patient should be kept lying down with head below level of feet to allow the vomit to drain away from air passages.

IN ANY EMERGENCY, THINK FIRST OF WATER.

Water dilutes the pesticide and quickly stops further damage. Transport victim to a doctor as quickly as possible.

POISON INFORMATION CENTRES

Two Poison Information Centres have been established in Ontario to provide information on all types of poisonings, including pesticide poisonings:

TORONTO: Hospital for Sick Children
(416) 598-5900
1-800-268-9017

OTTAWA: Children's Hospital for Eastern Ontario
Emergency Department
(613) 521-4040
1-800-267-1373 (from the 613 area code only)

Advice is available 24-hours a day, 7 days a week.

BE PREPARED

Prepare for an emergency by posting the Poison Information Centre number near the telephone and keeping a supply of syrup of ipecac available. Always have soap and water close by when working with pesticides.

PROTECTIVE CLOTHING AND EQUIPMENT

WHAT TO WEAR

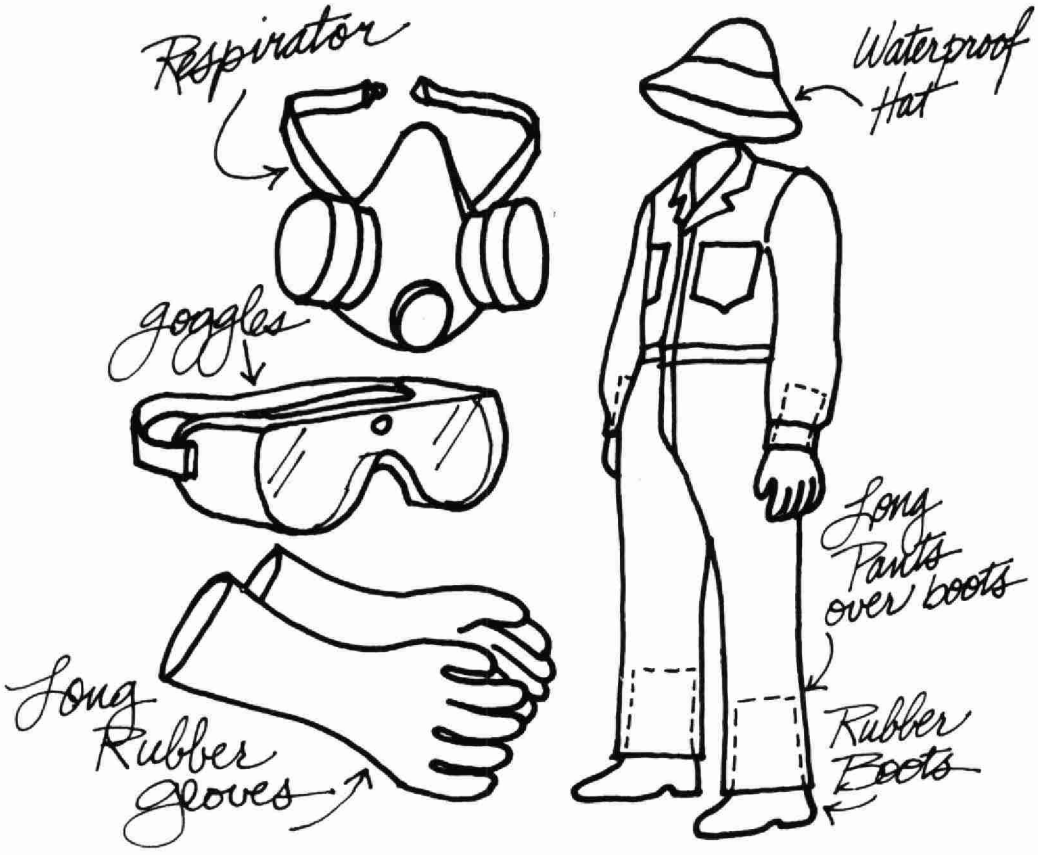
Direct contact with pesticides can be avoided by wearing the proper protective clothing and equipment. The hazards of pesticide usage can be reduced by knowing what protective clothing and equipment is available and how to use it. People who suffer from poisoning symptoms rarely make the same mistake twice. Someone who feels terrible after working all day with a toxic substance will usually protect himself next time. It is too late to start wearing protective gear after a serious medical condition has developed.

BODY COVERING

To protect the body, wear a long-sleeved shirt and long pants. Coveralls, worn over regular work clothes, provide good protection. A pair of coveralls can be set aside specifically for the purpose of spraying pesticides.

Disposable coveralls are another option. They give the user the convenience of discarding the coveralls after use. To discard, place the coveralls in a plastic bag and dispose of them along with the pesticide containers.

Some spray situations require additional protection. If working in a mist, water repellent clothing is advised. Use a rubber rainsuit. Extra protection is also necessary when mixing and loading the pesticide. During this time the pesticide is in a concentrated form and has not yet been diluted. Wear a rubber, neoprene or PVC apron to protect the front of the body from splashes and spills.



BOOTS

The feet can easily be contaminated when a user walks through spills, enters treated areas, tests spray nozzles or sprays close to the body. Wear unlined rubber boots for protection. Canvas or leather shoes and boots do not provide adequate protection. These types of footwear absorb the pesticide. Lined rubber boots are not advised for the same reason. The cloth lining absorbs the pesticide making it difficult to wash out. Wear pant legs outside the boots to avoid getting pesticides inside the boot. If the pesticide gets inside, wash and change boots and socks immediately.

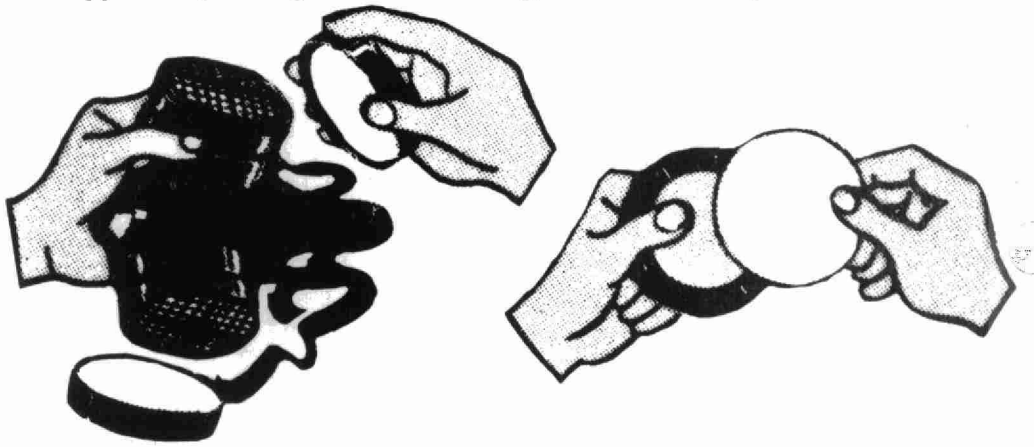
RESPIRATORS

A respirator is a unit that covers the mouth and nose to prevent spray droplets, particulates, and vapours from entering the lungs.

Air Purifying Respirators

The most common air purifying respirator is the half-mask chemical cartridge respirator. It consists of fibre filters to remove dusts and particulates and cartridges containing activated charcoal to remove vapours and spray droplets. Special filters and cartridges are available for protection against pesticides.

The filters should be changed after each use. Change the cartridges whenever the smell or taste of pesticides is evident, or at least after one year of use. For commercial applicators, cartridges should be changed on a more frequent basis.



The canister gas mask is another type of air purifying respirator. It is a full-face mask respirator covering the eyes as well as the mouth and nose. It is used in areas of high concentration of pesticide fumes.

Some situations require additional protection. For example, spraying pesticides inside a greenhouse. Powered air purifiers, like the helmet system, provide protection in enclosed areas with a high concentration of pesticides. The helmet system has a motor-blower which forces air through the filter and into the helmet. Breathing is easy because no effort is required to draw air through the filter. Besides respiratory protection the helmet system provides protection against dermal exposure to the head region.

When purchasing a respirator, it is necessary to make sure it fits properly. Be sure that no leakage occurs around the seal. To test, do a negative fit check. Cover the cartridges with hands and inhale. The mask will draw tightly to the face if there is no leakage. Facial hair, such as a beard, sideburns, or even a day's growth may prevent a proper fit. Cartridge respirators come in varying sizes to fit different shaped faces. Some full-face masks are also available.

Supplied Air Respirators

These respirators supply air through a tube to the headpiece from a tank on the wearer's back. They are designed for use in emergencies such as a fire in a pesticide storage or the application of fumigants in closed areas. The Self-Contained Breathing Apparatus (SCBA) is the most common one used.

GOGGLES

Give the eyes special consideration. Some pesticides cause eye irritation and even severe damage if they contact the eyes. And when in contact, absorption is 100%. Protect eyes by wearing goggles when there is any chance of getting pesticide in the eyes. Prescription eye glasses do not provide complete protection. Goggles will fit easily and comfortably over the top of normal eye glasses. Do not wear contact lenses when handling pesticides. Lenses absorb the pesticide and keep it in contact with the eye.

FACE SHIELDS

Overall face protection can be provided by a full-face shield. Face shields provide protection from the spills and splashes that occur during mixing and loading. When mixing and loading, the pesticide is in a concentrated form and has not yet been diluted. It is important to avoid getting this concentrated form on the skin. Face shields are comfortable to wear and fit easily over goggles. Some types attach to hard hats.

HEADGEAR

A waterproof hat should be worn to protect the head. A hard hat provides adequate protection in most spray situations and is usually easy to obtain. But, for more complete protection, a wide brimmed rubber rain hat is ideal, especially where the spray will contact the operator. Some rainsuits have hoods attached and these provide good protection to the head and neck areas. (In most cases though, where a tractor-drawn row-crop sprayer is used, a hard hat provides adequate protection.) Avoid wearing baseball type caps or hats with cloth or leather sweat bands. These materials absorb the pesticide and provide little protection.

GLOVES

The hands almost always become contaminated when using pesticides. To protect them, wear unlined, elbow length rubber gloves. Gloves made from neoprene or PVC also provide protection. Never wear gloves made from leather or cloth. These materials absorb the pesticide and keep it in contact with the skin.

For maximum protection, fold down the top of the gloves to make cuffs. This cuff will prevent the pesticide from running down the gloves and onto the arm when the hands are raised above the head. Wear the sleeves of the coveralls or shirt over the top of the gloves. Before using, check the gloves for leaks by filling them with water and gently forcing the water out to the finger tips. Gloves with leaks do not provide any protection. In fact, they help to increase absorption by keeping the pesticide in contact with the skin. Throw out damaged gloves. A wide selection of disposable gloves are now available from safety supply companies who can select the appropriate gloves for the chemicals being handled.

MINIMUM PROTECTION

When handling any pesticide, the user should wear:

- long-sleeved shirt } or coveralls
- long pants }
- gloves, unlined, elbow length
- rubber boots, unlined
- water repellent hat (hard hat)

EXTRA PROTECTION

Some situations require extra protection:

- water repellent suit (rainsuit)
- apron (rubber or PVC)
- goggles
- face shield
- respirator - air purifying or supplied air

TO CHOOSE PROTECTIVE CLOTHING AND EQUIPMENT CONSIDER:

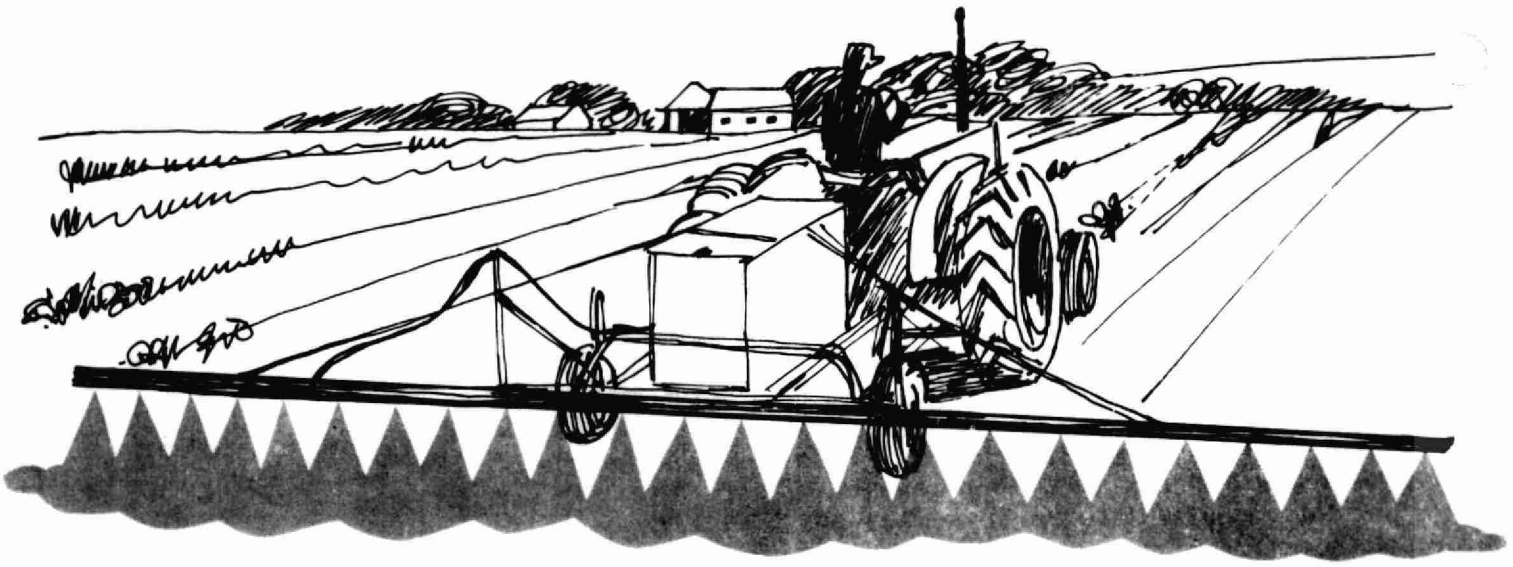
Everyone using pesticides should realize the importance of protective clothing and equipment in reducing exposure. The protective equipment needed depends on the pesticide and the spray operation.

THE PESTICIDE

The characteristics of pesticides vary greatly. Read the label to become familiar with the product. Guidelines on the proper protective equipment to wear is given on the label in the section titled, "PRECAUTIONS". Statements such as the following may be shown: "Avoid contact with the skin", "May cause eye irritation", and "Avoid breathing spray mist". Considering these statements, the user might wear gloves, coveralls, boots and hard hat (avoid contact with skin), goggles (may cause eye irritation) and a half mask cartridge respirator (avoid breathing spray mist). The statements in the precaution section will vary with each pesticide. Never assume that the precautionary statements will be the same for each pesticide. Always consider each product separately.

SPRAY OPERATION

The protective clothing and equipment chosen will depend on the spray operation. Consider the crop being sprayed; the pest being controlled; the equipment being used; and the weather conditions of the day. These are all factors which should be considered before deciding what protective equipment to wear. For example, if spraying soybeans with a tractor-drawn low pressure sprayer and keeping upwind, different protection will be needed than if spraying an apple orchard with an air blast sprayer. In the first case, coveralls and hat may provide protection. But, when orchard spraying, the user will become covered with the spray solution and should wear a rainsuit with hood, goggles, respirator, rubber boots and gloves. Each situation is unique. It is necessary to be able to assess the situation and decide what protective clothing to wear.



DEGREE OF PROTECTION

The spray operation can be divided into four stages:

- Preparation
- Mixing and Loading
- Application
- After Application

Each step requires different degrees of protection.

Preparation

Before measuring, mixing and loading, choose the protective clothing and equipment needed. Check the label and obtain the necessary equipment and make sure the equipment is in good shape. Change the filters and cartridges before using a respirator. Be sure there is plenty of soap and water available in case of an accident.

Mixing and Loading
Protective clothing and equipment is especially important during mixing and loading. Consider using rubber gloves, boots, goggles and a respirator even if the label does not suggest them. A rubber or PVC apron will provide extra protection to the front of the body. Mixing and loading is a time when there is a high risk of contamination from spills and splashes from the concentrated product.

Application
Protection during application will vary with the operation, i.e. row crop, seed treatment, orchard or greenhouse spraying. If the applicator will not come in contact with the spray solution, minimum protection may be adequate. But, some situations may occur when extra protection is needed such as machinery repairs. If possible, keep gloves, rubber boots, apron and goggles available while in the field. If it is necessary to make repairs, the applicator can put on the extra protective clothing. A small brush conveniently located on the tractor can help unclog spray nozzles.

After Application
Even though the spraying has been completed, the spray operation is not done until after clean up. Exposure can occur during clean up just as easily as during any other time in the spray operation. It is recommended that rubber boots, gloves and apron are worn during clean up. Splashing of the rinse solutions can easily occur while rinsing the spray tank. Extra protection is advisable.

CARE OF PROTECTIVE CLOTHING & EQUIPMENT

After the spray operation has been completed, protective clothing and equipment should be cleaned. Avoid contamination when removing clothing and equipment. Simply remove everything with gloves on. With hands still protected with gloves - wash protective equipment. Place coveralls in a plastic bag so that they can be laundered separately. Wash goggles, hard hats, gloves, boots, and rubberized clothing in warm soapy water, rinse and dry them. Remove the cartridges and filters from the respirator and wash the respirator in warm soapy water. Rinse and air-dry. Air-drying prevents the inlet and outlet valves from being damaged. Then wash the outside of the gloves with soapy water and remove them. Place dry articles in clean plastic bags and store in a cupboard until the next use.

Coveralls and other spray clothing must be laundered separately from other clothes. They should be washed after each use. Use rubber gloves to handle clothing. Machine washing will adequately remove pesticides from clothing but, if some clothing has been contaminated by spills with a highly concentrated pesticide, that clothing should be thrown out. Discard in a plastic bag and dispose of with the empty containers.

To wash:
- Presoak clothing before washing or use the prewash cycle of an automatic washer with detergent.
- Place coveralls or long-sleeved shirt and pants directly into the washing machine. Do not wash with other clothes.
- Use hot water (140°F), the highest water level and the superwash cycle, with heavy duty detergent. Wash as you would for heavily soiled clothing.
- Wash clothing again.
- After washing, hang outside (preferably in bright sunlight) until thoroughly dry.
- Run the washing machine empty through one complete cycle using detergent. This removes any leftover chemicals.

PERSONAL HYGIENE

When finished for the day, take a bath or shower as soon as possible and definitely before eating, drinking or smoking. The longer a pesticide remains on the skin, the greater the chance that it will be absorbed into the body. Shower with lots of soap and water and then change into clean clothes.

INTRODUCTION TO PESTICIDES

Farming practices today frequently require the use of chemicals to protect crops and animals from pests. There are six groups that cause major problems:

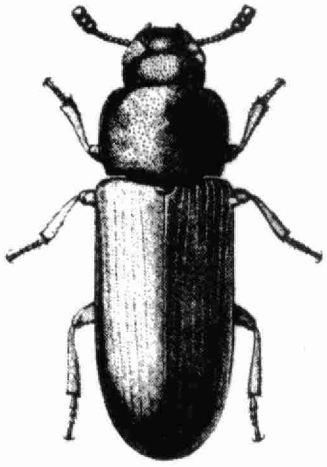
- insects
- mites
- weeds
- fungi
- rodents
- nematodes

Any chemical which is used by man to control a pest is called a pesticide. There are many different types of pesticides available and the choice of pesticide will depend on the pest to be controlled. For example,

acaricide	- a chemical used to kill or control mites, ticks and spiders
fungicide	- a chemical used to kill or control fungi
herbicide	- a chemical used to kill or control plants - mostly weeds
insecticide	- a chemical used to kill or control insects
miticide	- a chemical used to kill or control mites
molluscicide	- a chemical used to kill or control snails and slugs
nematocide	- a chemical used to kill or control nematodes
piscicide	- a chemical used to kill or control fish
rodenticide	- a chemical used to kill or control rodents

INSECTICIDES

Insects can be a major problem in many crops. They reduce crop yield and quality by feeding on the roots, stems, leaves and fruit of the crop plant. Harvested crops can also be attacked by insects while in storage thereby further reducing the quality of the product. In addition insects can spread plant diseases from plant to plant and from field to field. Because of insects' abilities to reduce a crop's potential value, man is interested in controlling their populations. When selecting an insecticide, a chemical capable of controlling insect populations, it is important to understand its mode of action and how it poisons the insect.

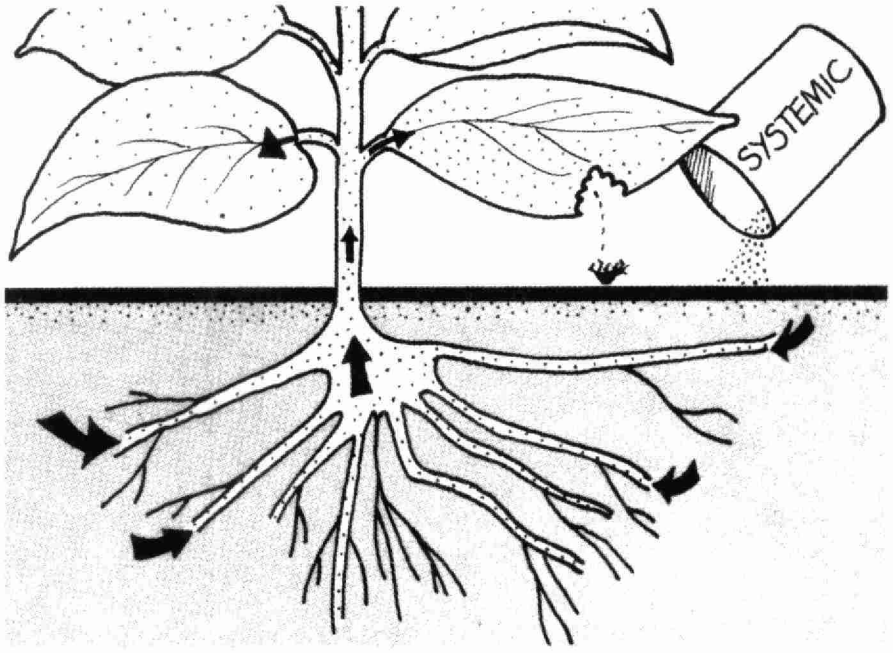


Stomach and Contact Insecticides

The earliest insecticides used by man were stomach poisons which were sprayed on the crop's leaves. When insects fed on the treated crop they also ingested the insecticide. Once inside the insect, the insecticide could move through the stomach to poison the insect. As advancements were made in insecticide chemistry it was no longer necessary for insects to solely ingest the insecticide, but only to come into physical contact with the material. Contact insecticides, are capable of poisoning insects after physical contact has been made. The poisoning symptoms may be instantaneous or they may take some time to show. Dust particles or spray droplets of contact insecticides can either hit the insect directly or more often be picked up by the insect as it moves across a deposit on the leaf. Today most insecticides are both stomach and contact insecticides - meaning that the pesticide can either enter through the insect's mouth or be absorbed through to its body. Good spray coverage is very important when applying an insecticide. The better the spray coverage achieved, the greater the likelihood that the insect pest will contact or ingest the pesticide.

Systemic Insecticides

It is now more important to know if the insecticide being used is a systemic or a non-systemic chemical. Systemic insecticides are capable of being applied to one portion of the plant such as the root or the leaf and moving (translocating) throughout the plant making the entire plant poisonous or toxic to an insect pest feeding on any plant tissue. Non-systemic insecticides do not move within the plant. To be effective the insect pest must ingest or come in contact with a portion of the plant that was treated with an insecticide. It is important to realize that although an insecticide may be classified as a systemic, it may require a certain application method to be effective. Some systemic insecticides must be applied to the crop's root area to be translocated within the plant. Others may be sprayed on the crop foliage to move throughout the plant's system. While complete coverage may not be vital with systemic insecticides, it is very important that sufficient chemical be applied to the plant to afford protection and that sufficient time be allowed to permit translocation within the plants before insect feeding occurs.



HERBICIDES

Weeds have the ability to grow each year in crops. Herbicides are chemicals which man uses to control weeds. Herbicides can be grouped into categories depending on their mode of action, the plant species which they control or how long the herbicide controls the weeds.

Mode of Action
Contact herbicides, as the name implies, kill only those plant parts which the herbicide contacts. Enough of the plant surface must be contacted in order to kill the entire plant. Systemic or translocated herbicides enter the plant and move within the plant's system adversely affecting the growth of that plant.

Selectivity
Herbicides may be selective or non-selective, that is they may control only certain plant species or they may inhibit the growth of all vegetation within the treated area. Selective herbicides kill certain plants without killing other vegetation. These herbicides when used at the proper time and rate can control weeds within a crop. For example, there are herbicides that provide control of broadleaf weeds and not grasses. Non-selective herbicides are used to control all the vegetation in the treated area.

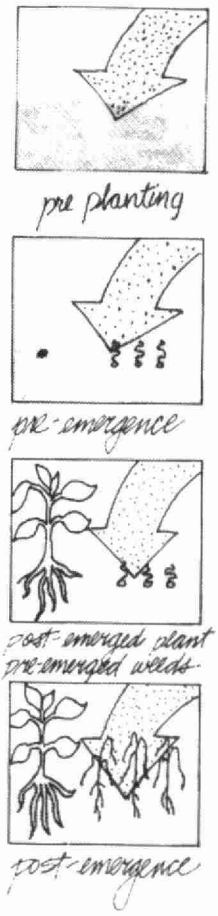
Residual Effects of Herbicides
Non-residual herbicides are chemicals which are either quickly broken down in the soil or are inactivated by the soil soon after application. These herbicide residues do not present a problem to future crops. Residual herbicides are those which do not break down very quickly in the soil and therefore provide long-term control of weeds. These herbicides can remain active in the soil for more than one year and can carry over in the soil into the second or, in some cases, the third growing season and affect those crops sensitive to the herbicide.

Time of Herbicide Treatment in Crop Areas
The susceptibility of both crops and weeds to herbicides is related to the time of application. Therefore, it is important to use the chemical at a time when the crop is at its maximum resistance and the weeds are at their maximum susceptibility. This time will vary depending on the crop involved and the herbicide being used. Different terms which describe the times at which herbicides may be applied have come into general use.

Pre-plant Treatments - Pre-plant treatments are applied before the crop area is sown or planted. Some herbicides used in this way act on germinating seedlings, others may also kill weed seeds. Most herbicides, when used pre-plant, must be thoroughly incorporated with the soil soon after application.

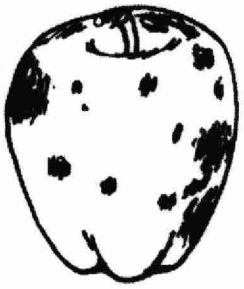
Pre-emergence Treatments - Chemicals used in pre-emergence treatments are applied after seeding but before the specified weed or crop emerges. The chemicals may control weeds by killing weed seedlings and/or establishing a toxic layer of chemical on or near the soil surface in which germinating seeds and young seedlings cannot survive. For successful pre-emergence treatments, the crops must either be tolerant of the chemical at the seedling stage or the toxicity must have disappeared before the crop emerges. A smooth, well-prepared seed-bed which is free of clods is necessary for best results. The surface soil should also be moist and the temperature favourable for the rapid germination of weed seeds.

Post-emergence Treatments - Post-emergence treatments are applied after the crop and weeds have emerged. A selective chemical is used and the weeds are killed with little damage to the desirable plants. The types of weeds that may be controlled depend on the susceptibility of the weed, and the tolerance of the crop to the chemical. Treatment at the correct stage of crop development is important. Since most weeds are more susceptible to chemicals when young, early treatments will require less herbicide and will result in less damage to crops from weed competition and from spray equipment.



Sometimes a herbicide may be applied post-emergence to the crop but pre-emergence to the weeds. For example, a crop may be cultivated, then a herbicide applied to the weed free soil to control subsequent germinating weeds.

FUNGICIDES



There are many diseases such as molds, rots, rusts and wilts that attack plants. Many of these plant diseases can be controlled by fungicides. Fungicides are chemicals that either kill a portion of fungal growth or stop the fungus from producing spores (the fungi's seeds).

Protectants

Protectants are fungicides which are designed to protect the plant from diseases. These fungicides must be applied to the plant or seed before the disease occurs. Protective fungicides remain on the plant's surface for a week or more. Once this type of chemical wears off or new plant growth occurs there is no longer an effective chemical shield between plant and fungus. It is necessary to ensure that susceptible plants have a protective layer of fungicide on the surface at all times by adopting a spray schedule based on a seven to ten day interval. These fungicides are routinely used in orchards and vegetable crops.

Eradicants

Eradicants control fungi which have already infected the plant. Eradicants are used when protectants are not available for the control of a fungal disease or if a sufficient chemical shield was not maintained and the disease has become established in the plant. Fungicides can be applied to the growing crop and/or to the seed as a seed treatment. Many are mixed with insecticides such as lindane for dual purpose seed treatments.

RODENTICIDES

Rodenticides are pesticides which kill rodents such as mice and rats. Most rodenticides are anticoagulants, that is they cause the blood to lose its ability to clot and rodents die from internal bleeding. Warfarin is an example of an older anticoagulant whereas brodifacoum and bromadiolone are newer anticoagulants. Most rodenticides are prepared as baits. The animals feed on the pelletized bait and die three to four days later. Care should be taken in preparing bait stations so as to prevent feeding by non-target species such as birds, dogs, cats, etc.

MITICIDES

Miticides (or acaricides) are pesticides used to control mites. They are very similar to insecticides some of which will also control mites.

NEMATOCIDES

Nematocides are pesticides used to control nematodes, small round worms that cause damage to the roots of plants. Since these worms live in the ground, nematocides are usually soil fumigants.

SELECTING A PESTICIDE

PEST IDENTIFICATION

The most important step when selecting a pesticide is to identify the pest that requires control. If help in identifying the pest is needed, it may be easily obtained from the local Ontario Ministry of Agriculture and Food office, the local pesticide vendor, agriculture colleges, or with help from OMAF factsheets/publications.

Besides knowing what the pest is, it is also important to know at what stage and time the pest can best be controlled. Usually a pest is more susceptible during one particular stage of its development. For example, annual weeds are best controlled when they are young seedlings whereas perennial weeds are often best controlled with a herbicide application during the flowering period. Therefore, to obtain the best control, the applicator must know:

- what the pest is
- when the pest can best be controlled
- which control method, if any, will control the pest.

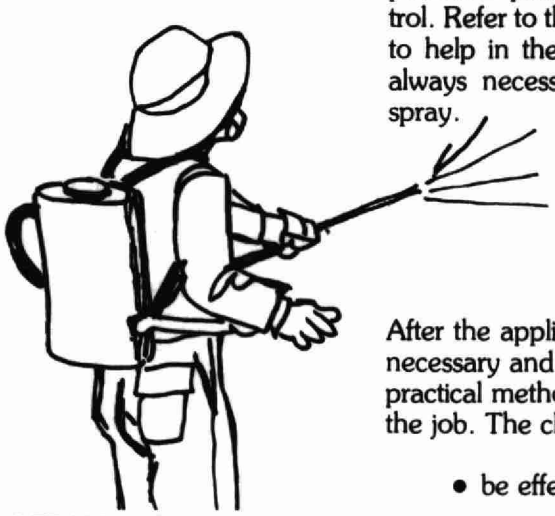
DETERMINE IF CONTROL IS NECESSARY

All crops will contain a certain number of pests. It will have to be decided if a pest's population requires control. The damage from the pest population may not be as costly as a pesticide application, or the pests may become established in the crop when they no longer present any harm to the crop.

ALTERNATIVES TO PESTICIDE APPLICATION

Methods of pest control may be used that do not require a chemical treatment. These methods give either physical, cultural or biological control of the pest. Physical control of pests occurs when the pest is physically removed from the crop. Common examples of physical control include pruning of fruit trees to remove fire blight and the cultivation of fields to control weed populations. Cultural methods of pest control use practices common to good land management to lower pest populations. By planting certified seed (which is low in weed seeds and plant disease inoculum) and using crop rotation, a grower is using cultural pest control methods. An economical method of protecting crops from

pests is to plant disease/insect resistant varieties - a biological method of pest control. Refer to the Ontario Ministry of Agriculture and Food crop recommendations to help in the selection of resistant crop varieties. A pesticide treatment is not always necessary or economical. Check other possibilities before deciding to spray.



SELECTION FACTORS

After the applicator has identified the pest, determined that a control measure is necessary and considered other methods of control he may decide that the only practical method is to use a pesticide. He must now choose the best pesticide for the job. The chosen pesticide should:

- be effective against the pest
- be registered by Agriculture Canada and scheduled in Ontario by the Ministry of the Environment for use on the crop
- fit in with the work schedule. Take into account minimum re-entry periods (specified on label) so that the pesticide can be applied and not interfere with other operations, i.e. trimming, harvesting, packing.
- compliment the harvest date. Some pesticides must be applied a specific number of days prior to harvest to reduce pesticide residues in the crop. Indicated on the pesticide's label as "days to harvest interval".
- present the least hazard to the applicator and others who could be exposed to the application. The label will have a hazard symbol indicating potential hazard of the product.
- have the least effect on beneficial species. For example, bees are required for the pollination of many crops. If bees are foraging or are located nearby use a product with low toxicity to bees (refer to the Ontario Ministry of Agriculture and Food publication #360 - Fruit Production Recommendations) or spray at a time when bees are not foraging in the crop. (Never apply insecticides while fruit trees are in bloom).
- discourage pest resistance. If the pest is resistant to a pesticide product or has developed resistance at other locations, alternate the pesticide with other products to avoid the development of resistance. Consult the local Ontario Ministry of Agriculture and Food Office.
- be compatible. If tank mixes with another pesticide are required, select a product which is known to be compatible with the other product to be applied.
- minimize exposure. Select the formulation type which will minimize exposure to the applicator during mixing and loading and provide the minimum injury to the crop to be sprayed.
- be able to be applied correctly with the application equipment available.
- control secondary pests. If secondary pests are present, select a product to provide the most effective control.

THE LABEL

The information on a label has been called the **most expensive** literature in the world. The research and development that leads to producing a label costs millions of dollars. A label is the result of the combined efforts and knowledge of chemists, toxicologists, pathologists, entomologists, weed scientists, and many others from government, industry and universities.

Appreciate the information on a label! A pesticide label is a legal document.

READ THE LABEL

The information on a label is important to four groups of users:
1. **The GROWER,** - for information on how to use the product correctly, legally and safely.
2. **The MANUFACTURER,** - the label is their "licence to sell".
3. **The PHYSICIAN,** - a source of information on the proper treatment in case of poisoning.
4. **The GOVERNMENT,** - method to control product use, distribution, storage and disposal.

The information on the label is legally binding. A person cannot suggest or recommend to a purchaser a use or information that is not on the label. If a use is not specified on the label, it is considered to be an improper application and an illegal usage of that product.*

Fig. 8-1 shows a typical pesticide label. There are two main parts. The front panel or "principal display panel" and the back or side panel or "secondary display panel". A complete label may also include information in a separate booklet if all the information will not fit on the container panels. It could include stickers, tags, seals, leaflets, brochures and wrappers on, or attached to, a container. Always make sure that you have all the information on the product you are using.

THE PRINCIPAL DISPLAY PANEL CONTAINS:

1 PRODUCT NAME

The product name consists of a trademark, registered trademark (Control-All) or common name, formulation type (E.C.) and use description (herbicide).

2 CLASSIFICATION

All pesticides are classified federally primarily by use and secondarily by toxicological and environmental criteria as either DOMESTIC: COMMERCIAL: RESTRICTED: or MANUFACTURING.
SEE "SPECIAL LABELLING FOR RESTRICTED PRODUCTS".

Domestic. All products of low toxicity, sold in small packages and intended for use in or around the home.

Commercial. All products of low or medium toxicity not sold to the homeowner. More descriptive terms such as AGRICULTURAL or INDUSTRIAL may be used.

Restricted. Products with restricted use due to concern for the health of man or the safety of plants, animals or the environment.

Manufacturing. Products used in manufacturing, formulating or repacking.

3 NET CONTENTS

The net contents are expressed on the label in metric units.

4 READ THE LABEL

The Pest Control Product Regulations require that the statement "READ THE LABEL BEFORE USING" appear on the front panel.

*It is possible that a use may be registered and not appear on a label. This may be the case if the use has been recently registered and the printing of the label delayed. This most often occurs if the crop is a minor use crop.

5 KEEP OUT OF REACH OF CHILDREN

The required statement, KEEP OUT OF REACH OF CHILDREN, must appear on the principal display panel or on the secondary display panel. In this case, it appears on the principal display panel.

6 PRECAUTION SYMBOLS AND WORDS

Precautionary symbols and words are placed on the label to depict the toxicity of the product. These are standardized and outlined in the Pest Control Products Regulations. The chart (Fig. 8-2) explains the symbols and words.

7 GUARANTEE

The guarantee states the active ingredient and its concentration in the product. The concentration is given as a percentage by weight (eg. 40%) or weight per unit volume (g/L). The active ingredient is a common chemical name that becomes internationally known to identify the pesticide.

8 REGISTRATION NUMBER

Once registered, each product is given a registration number by Agriculture Canada. This identifies the product with Agriculture Canada and the manufacturer.

9 NAME AND ADDRESS

The name and postal address of the registrant appears on the label, usually at the bottom. This ensures that the registrant can always be contacted for additional information.

THE SECONDARY DISPLAY PANEL CONTAINS:

10 DIRECTIONS FOR USE

Directions for use includes information on
- what pest it can be used on (weed, insect, disease)
- what crops it can be used on
- how to apply the product
- how to protect the crop
- use limitations, i.e.
  - pre-harvest intervals
  - application restrictions
  - post treatment restrictions (safe re-entry intervals)

11 CAUTIONARY STATEMENTS

The precautions include statements on the hazards and restrictions of the product and outlines the personal precautions that must be followed when handling the pesticide.

12 FIRST AID

Practical first aid measures to be taken in the event of a poisoning or an injury are listed on the secondary display panel.

13 TOXICOLOGICAL INFORMATION

The toxicological information provides additional information not given in the first aid section which may include the symptoms of poisoning and the antidotes to be administered by a physician. Also noted are any ingredients in the product other than the active ingredient, which may affect the treatment of a poisoning (i.e. petroleum distillates).

14 NOTICE TO USER AND NOTICE TO BUYER (LIMITATION OF WARRANTY STATEMENT)

The "Notice to User" disclaimer appears on all Commercial and Restricted class labels and may appear on Domestic class labels. The "Notice to Buyer" disclaimer may appear on all labels including Domestic class where a registrant wished to include it.

Fig. 8-1

EXAMPLE LABEL

PRINCIPAL DISLAY PANEL

2 AGRICULTURAL **3** 10L

1 **CONTROL-ALL®**
500 E.C.

Emulsifiable Concentrate
Herbicide

4 READ THE LABEL BEFORE USING

5 KEEP OUT OF REACH OF CHILDREN

6 CAUTION  POISON

7 GUARANTEE: Monolochlor 500 g/L

8 REGISTRATION NO. XXXXXX - Pest Control Products Act

9 RIDGETOWN COLLEGE OF AGRICULTURAL TECHNOLOGY
RIDGETOWN, ONTARIO
N0P 2C0

SECONDARY DISPLAY PANEL

10 **DIRECTIONS FOR USE:**
SOYBEANS: To control broadleaf weeds and grasses, apply 1.75 to 2.5 L/ha when soybeans are at the 2 to 4 trifoliate. Apply in 45 to 225 L of water per hectare. Do not apply when temperatures are above 25°C. Do not apply within 30 days of harvest. Do not feed treated foliage to animals.

11 **PRECAUTIONS:**
Harmful if swallowed, inhaled or absorbed through the skin. Avoid breathing vapour or spray mist.
Avoid contact with eyes, skin and clothing.
Wash thoroughly after handling and before eating, drinking and smoking.
Do not spray near desirable, susceptible plants.
Do not allow spray to contact susceptible plants.
Coarse sprays are less likely to drift.
Avoid contamination of food for human consumption or livestock feed.
Do not contaminate water supplies or any bodies of water.
Triple rinse the container, draining rinsate into the spray tank.
Do not re-use container. Crush or break empty container and dispose of container in an approved sanitary landfill site.
Avoid freezing. If subjected to freezing temperatures, warm to at least 5°C and mix thoroughly before using.

12 **FIRST AID:**
In case of poisoning, call physician.
If on skin, wash thoroughly with soap and water.
If in eyes, flush with water for 5 to 10 minutes and get medical attention.
If swallowed, do not induce vomiting.
This product contains a petroleum distillate. Call a physician immediately.

13 **TOXICOLOGICAL INFORMATION**
Symptoms include nausea, vomiting, pin-point pupils, convulsions and coma. This product may cause cholinesterase inhibition. ATROPINE is ANTIDOTAL. Give 2 to 4 mg. of atropine sulphate intramuscularly or intravenously immediately and every hour as required until pupils dilate.

14 **NOTICE TO USER**
This control product is to be used only in accordance with the directions on this label. It is an offence under the Pest Control Products Act to use a control product under unsafe conditions.

NOTICE TO BUYER (LIMITATION OF WARRANTY STATEMENT)
Seller's guarantee shall be limited to the terms set out on the label and, subject thereto, the buyer assumes the risk to persons or property arising from the use or handling of this product and accepts the product on that condition.

SPECIAL LABELLING FOR RESTRICTED PRODUCTS

If a product has been classified as RESTRICTED, certain statements must appear on the label at the top of the secondary panel, before the directions for use. The following is an example of a restricted product requiring a provincial permit before use.

> **NOTICE TO USER: This control product is to be used only in accordance with the directions on the label. It is an offense under the Pest Control Products Act to use a control product under unsafe conditions.**
>
> **RESTRICTED USES**
> **NATURE OF RESTRICTION: Studies on the safety of this product for users and spray operators are not complete. Directions for use and precautionary statements should be followed carefully.**

The "Nature of Restriction" varies depending on the use and is decided between Agriculture Canada and the registrant. Other statements may be concerned with storage, display, distribution or defining who may use the product. Another example is the following:

> **NATURE OF RESTRICTION: This product is to be used only in the manner authorized: contact local pesticide regulatory authorities about use permits which may be required. This product is to be stored and displayed apart from food and feed.**

HAZARD SYMBOLS & WORDS

To indicate how acutely toxic, corrosive, flammable or explosive a chemical is, these primary hazard symbols are placed in the three precautionary symbols depicted below.

Fig. 8-2

SYMBOL	SIGNAL WORD
	POISON
	CORROSIVE
	FLAMMABLE
	EXPLOSIVE

PRECAUTIONARY SYMBOLS & WORDS

Fig. 8-3

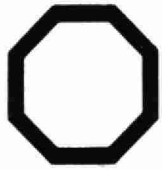
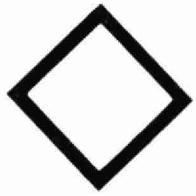
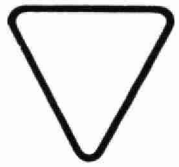
	SYMBOL	SIGNAL WORD
Octagonal shape indicates HIGH HAZARD		DANGER
Diamond shape indicates MODERATE HAZARD		WARNING
Triangular shape indicates LOW HAZARD		CAUTION

Fig. 8-4

INTERPRETATION OF SYMBOL COMBINATIONS

	 DANGER POISON	 WARNING POISON	 CAUTION POISON
Acute oral LD_{50}	◄500	500-1,000	1,000-2,500
Acute dermal LD_{50}	◄1,000	1,000-2,000	2,000-5,000
Respirator	YES	advisable in confined spaces	advisable in confined spaces
Eye Protection	YES	YES	advisable
Eye Effects	corrosive or irreversible	severe but reversible	irritation
Petroleum Distillates	10% or more	1% to 10%	—

	 DANGER FLAMMABLE	 WARNING FLAMMABLE	 CAUTION FLAMMABLE
Liquid Products - Flash-point	◄-6°C (20°F)	-6° to 10°C (20 to 50°F)	10° to 27°C (50 to 80°F)
Pressurized Products - Flame projection	45 cm (18")	15-45 cm (6 to 18")	◄15 cm (6")

	 CAUTION EXPLOSIVE
All domestic Aerosols, Pressurized	

	 DANGER CORROSIVE	 WARNING CORROSIVE	 CAUTION CORROSIVE
acid or alkali materials	10% or more	►5% & ◄10%	►1-5%
organic acids	20% or more	►5% & ◄20%	►1-5%
available chlorine	—	10% liquid	►1% solids, ►1% to ►4% liquids
pH	—	◄0.5 or ►13.5%	0.5 to 2.5 or 11.5 to 13.5

EYE HAZARD

Some products cause varying degrees of hazard to the eye. Depending on the hazard, the following words may appear on the label:

DANGER — CORROSIVE TO EYES
DANGER — EYE IRRITANT
WARNING — EYE IRRITANT

MULTIPLE SYMBOLS

If the product is hazardous in more than one way, all the hazard symbols and words are required on the label but only the most severe **precautionary** word is required. For example,

POISON

DANGER

FLAMMABLE

EXPLOSIVE

For each level of hazard, different safety precautions should be taken to minimize the exposure and specific first-aid steps taken in case of an accidental poisoning.

Read the pesticide label
Information on the degree of hazard, safety precautions that are necessary, and first-aid procedures are on the label. Since each pesticide is different, it is necessary to read the label and interpret the information to apply to your situation. Additional information is available from the manufacturer on toxicology and safe use.

READ THE LABEL

READ THE LABEL BEFORE BUYING, BEFORE USING OR APPLYING AND BEFORE STORING OR DISPOSING OF THE PESTICIDE.

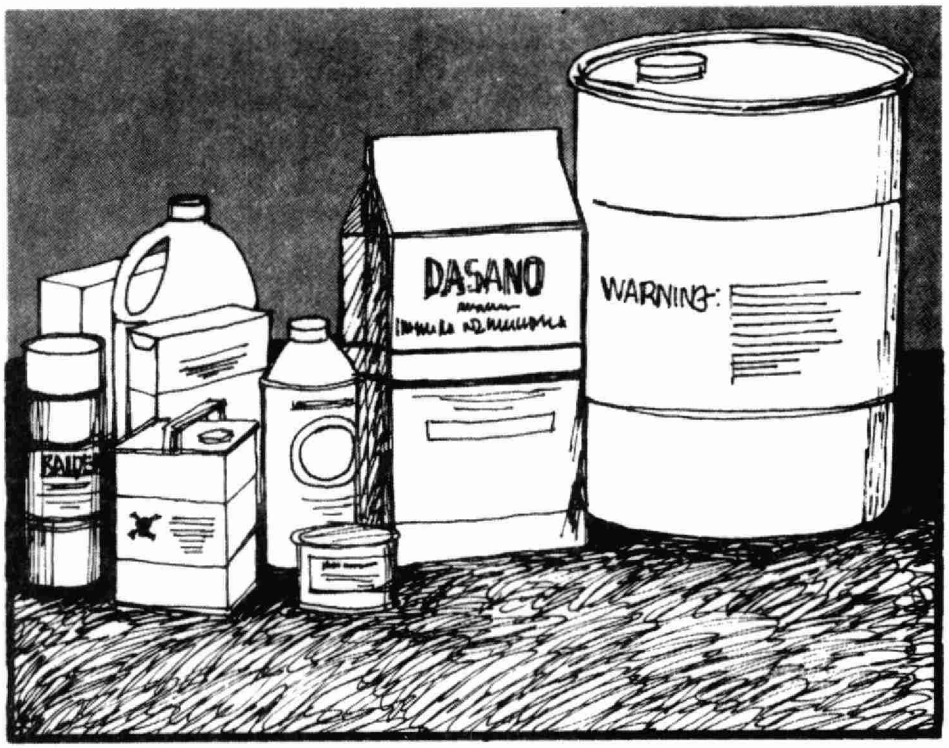
Before Buying
Read the label to determine if this product will control the pests on the crop. Check to see how to use it safely and check the formulation type. Finally, check the rate to determine the amount of product needed.

Before Using
Gather together the necessary protective equipment. Read the warnings and the first aid section to prepare for an accident. Check for its compatibility with other pesticides and look for any other use restrictions, then determine how much to use, when to apply and how.

Before Storing or Disposing
Read where to store and where **not** to store. Follow the directions to dispose of the container and any left over material.

FORMULATION TYPES

Pesticides are sold in many formulations and a single pesticide may even be sold in more than one formulation.



The type of formulation depends on several factors:

- chemistry of the active ingredient
- toxicology of the active ingredient
- efficacy of the product on the pest
- the effect of the product on the plant, animal or surface
- the effect of the product on the environment
- the application technique (equipment)
- the application rate

A formulation consists of one or more active ingredients (a.i.) plus inert ingredients (materials with no pesticidal action). An inert ingredient may be talc in a dust formulation or petroleum distillate in an emulsifiable concentrate formulation. It may be necessary to include other inerts such as solvents, wetting agents, extenders or emulsifiers. A formulation is developed to make the product safer and more convenient to use. Some products are ready to use and require no further mixing although most products applied in the liquid form require dilution in water or oil before use.

Formulations can be subdivided into solids, liquids and gases.

SOLIDS	Dusts or Powders, Granules, Pellets, Tablets, Particulates, Dry Flowables
LIQUIDS	Suspensions (Flowables), Solutions, Emulsifiable Concentrates
GASES	Fumigants sold as liquids or solids

ABBREVIATIONS

Abbreviations are often used behind the trade name on the pesticide label to indicate the type of formulation:

D	Dust
DF	Dry Flowable
EC	Emulsifiable Concentrate
F	Flowable
G	Granular
P	Pellet
S	Solution
Sc	Sprayable Concentrate
Sn	Active Solution
SP	Soluble Powders
WDG	Water Dispersible Granules
WP	Wettable Powders
WS	Water Soluble Concentrate

The following chart summarizes formulation types and lists some of the advantages and disadvantages of each type.

SUMMARY OF FORMULATION TYPES

LIQUIDS

NAME	DESCRIPTION	ADVANTAGES	DISADVANTAGES	TYPICAL USE
Aerosol	A liquid with one or more solvents. Ready to use in pressurized containers.	No mixing required. Low concentration of a.i.	Pressurized containers are hazardous if punctured or heated	Flying insect control
Emulsifiable Concentrate	A clear solution with emulsifiers for dilution in water. Final spray solution is a milky colour.	A high concentration of a.i. supplied per container. Buy less bulk	Possibly flammable	Agricultural sprays
Micro-encapsulated Suspension	A suspension with a.i. in micro-capsules giving a slow release of a.i.	See comments on E.C.'s. Increases the residual of a.i. Reduces hazard to operator	May be expensive	Insecticides
Suspension or Flowable	A cloudy liquid composed of solid particles of a.i. (finely ground) in a liquid. Needs dilution.	See comments on E.C.'s	Active ingredient may settle out of formulation	Agricultural sprays
True Liquid/ Solution	a.i. is in solution, usually water and when mixed with water remains clear	See comments on E.C.'s Requires little agitation when added to water in spray tank	Possibly corrosive	Agricultural sprays
Ultra-low Volume (ULV) Concentrate	Solution of a.i. designed to be used undiluted only in ULV equipment. Very high concentrate of a.i.	Use without mixing	Concentration of active ingredient during application makes them hazardous. Special equipment required	Insecticide sprays normally inside structures, forestry

SOLIDS

NAME	DESCRIPTION	ADVANTAGES	DISADVANTAGES	TYPICAL USE
Dry Flowable	A wettable powder which is formulated into small pellets or granules	Less dusty than WP formulations and easier to handle	Requires agitation in spray tank	Agricultural pesticides
Dust or Powder	A finely ground dry material of a low concentration (a.i.) plus inerts such as talc. No dilution needed before use.	Ready to use	Dusty. Drifts and very visible on surface.	Spot treatment Animal powder
Granular	A mix of dry, large, free-flowing particles usually with a low concentration of a.i.	No mixing required. Ready to use. Drift minimal	Some dust. Requires special application equipment.	Soil treatment for insect or vegetation control

NAME	DESCRIPTION	ADVANTAGES	DISADVANTAGES	TYPICAL USE
Impregnated Fertilizer	Granular fertilizer containing low amount of herbicides	One step application. Low a.i. concentration Not dusty	Could clog equipment	Agricultural soil application
Particulate or Bait	Mixture of large particles not recognized as a pellet or granular formulation. Mixed with edible inerts.	Easy to spot treat	Accessible to pets and children	Bait for insects or rodents
Pellet	Preformed mixture of a.i. and inerts to form spheres or cylinders	As above	As above	Baits to control rodents, slugs
Seed Treatment	A finely ground dry material containing a dye, usually red	Colours seed to distinguish it from untreated	Care must be taken with dye	Seed treatment
Soluble Powder or Granules	A dry material similar to dust or granules above except it is soluble in water	Containers empty easily. No liquid spills.	Dusty	General use
Tablet	A preformed "tablet" composed of inerts and a.i.	Easy to measure & use	Accessible to pets and children	Fumigant
Wettable Powder	a.i. added to powder (clay, talc) contains a wetting and dispersing agent. Forms a suspension in water	Containers empty easily. No liquid spills	Dusty. Requires agitation to remain in suspension	Agricultural sprays

GASES

NAME	DESCRIPTION	ADVANTAGES	DISADVANTAGES	TYPICAL USE
Fumigants	Volatile liquids or solids packaged for release as a gas	Toxic to many forms of the pest at one time. Penetrates cracks and crevices	Area to be fumigated must be well sealed. Highly toxic	Greenhouses Mushroom houses Other structures Bulk containers (ships, rail cars, etc.)

OTHER FORMULATIONS

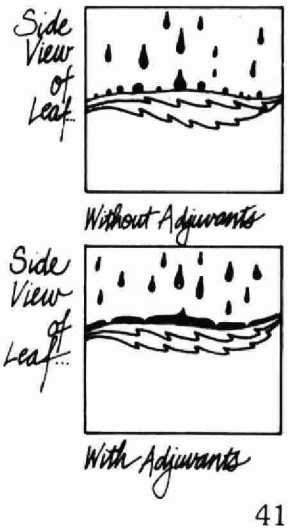
Other available pesticide formulations less commonly used include paints and soluble packages.

Paints have the advantage of being easy to handle. They spread easily over a surface.

Soluble packages are made from soluble plastic in which pre-measured amounts of pesticide have been packaged. This type of packaging was developed to reduce dermal exposure and improve accuracy in measuring amounts needed. Once immersed, they dissolve rapidly. Care must be taken to avoid splashing unused packages. Care should also be taken that the screens in the sprayer do not become clogged.

ADJUVANTS

The effectiveness of some pesticides may be improved by the addition of adjuvants to the product in the spray tank. An adjuvant is a substance added to a pesticide spray tank to improve the effectiveness of the active ingredient. An example of a commonly used adjuvant is a surfactant. Surfactants are "surface active agents" whose purpose is to improve pesticide uptake.



Adjuvants may improve the effectiveness of a pesticide in the following ways:

- Wetting the surface: the spray may stick to the surface better
- Increasing/decreasing evaporation: an adjuvant may prevent the spray from drying too fast or help it dry more quickly
- Increasing absorption into the plant: this is important if the pesticide must enter the plant to be effective
- Improving spray droplet uniformity: this gives more complete coverage of the target surface, placing the pesticide where it can be more effective

PESTICIDE COMPATIBILITY

When two or more pesticides are added to a spray tank, mix satisfactorily and when combined work effectively together, they are considered compatible. If when mixing, a separation, coagulation, gel or curd is obtained, they are then incompatible and should not be used. Before combining pesticides, they must be proven to be compatible. Check the label for product compatibility or refer to compatibility charts available through industry or government extension services. Combining two chemicals which are incompatible is costly and time consuming. Mixing more than two pesticide types is not encouraged. It is not recommended to use an insecticide plus fungicide plus miticide in the same tank. Avoid these cocktail mixtures. Poor results or crop injury may result. In addition, if such mixtures are not registered their use would be illegal under the federal Pest Control Products Act. Residues remaining on the crop could be in contravention of the federal Food & Drugs Act.

SYNERGISM

At times combining two or more pesticides will provide better control than when each is used alone. This could be a result of synergism. Synergism, or potentiation, is the increased effectiveness achieved when two chemicals are used together compared to their effectiveness when used alone. For example:

Chemical A controls 60% of the pest
Chemical B controls 20% of the pest
Chemical A + B controls 98% of the pest

Synergism increases control so that less chemical may be required. Pesticide tank mixes may have synergism if each pesticide controls a different life stage of the pest population. This is an asset during a busy spray season. It is convenient and economical to combine pesticides so that only one application must be made.

TRANSPORTATION OF PESTICIDES

Great care must be taken in the transport of pesticides. Legislation exists at both the federal and provincial level to ensure safe transportation of pesticides.

FEDERAL LEGISLATION

TRANSPORTATION OF DANGEROUS GOODS ACT

Transportation of pesticides is regulated federally under the Transportation of Dangerous Goods Act administered by Transport Canada. The purpose of the Act is to promote public safety in transportation of dangerous goods. Failure to comply with the Act or Regulations can result in a maximum fine up to $100,000 and/or 2 years imprisonment. A person is not guilty if he establishes that he took all reasonable measures to comply with the Act/Regulations.

The major requirements are that no one shall transport potentially hazardous quantities of dangerous goods unless they are properly trained and use the required shipping documents, special product labels, vehicle placards and follow certain safety procedures. The classes of dangerous goods and quantities which require special handling and transport procedures are identified in the Regulations. Many pesticide compounds are included in classes of dangerous goods known as "poisonous substances", "flammable liquids" or "products hazardous to the environment".

Pesticides are exempt from certain requirements of the Transportation of Dangerous Goods Act under the following circumstances:

- Most of the requirements do not apply to transport of pesticides by road between a retail store and the residence of the purchaser or location of use, where pesticides are in approved packages or a container with a volume not greater than 454 L. (There are restrictions on the package size of certain pesticides carried in a vehicle with passengers).

- Most of the requirements do not apply to transport of pesticides by road in licensed farm vehicles where quantities are less than 500 kg and the distance travelled from a farm to the place of pesticide use is not more than

50 km. However, persons involved in such transport must be properly trained to handle dangerous goods and must report serious accidents involving pesticides to the police and Transport Canada.

- The requirements do not apply to transport of pesticides by aircraft, where the pesticides are to be dispensed during aerial spraying if the following conditions apply: the pesticides are in containers with a capacity of less than 220 L, the containers provide the required level of safety, the containers are marked with the pesticide classification, the aircraft is a cargo aircraft, the pilot supervises the loading, the aircraft compartments with pesticides are ventilated, smoking is prohibited on the aircraft, and the local authority where the plane takes off is notified that dangerous goods are being transported.

- Where tanks of pesticide spray are being transported by road, and the tank is used for holding a solution prior to or during application procedures, and the tank volume is 5,000 L or less, shipping documents are not required.

- Pesticides that are considered hazardous to the environment, but are not in the poisonous substance category, do not require placards on the transport unit.

Where the above exceptions do not apply, the classification of a pesticide should be identified from the Regulations to determine whether some or all of the following items are required:

1. shipping documents which indicate the shipper, destination, type of product, product classification, degree of hazard, emergency telephone numbers, etc.;

2. a specific hazard warning level on every pesticide package;

3. placards with material identification numbers and symbols on the outside of vehicles (not required when carrying less than 500 kg of poisonous substances);

4. a summary of an emergency response plan for certain quantities of more hazardous substances filed with Transport Canada;

5. appropriate packaging of dangerous goods during transport;

6. training of persons involved in transport of dangerous goods; and

7. reporting of accidents that represent a danger to health, life, property or the environment and involve at least 5 kg or 5 L of poisonous substances or at least 1 kg of substances hazardous to the environment.

All agencies handling pesticides at the manufacturing, formulating or wholesale level should be familiar with the details of these requirements. Commercial pesticide applicators who transport pesticides from storage areas to application sites or to other storage sites (except by registered farm vehicle) should be familiar with requirements for the specific pesticides they handle.

This Act is very comprehensive and separate licensing courses on this Act are available for those whose operations are covered by this Act. At present pesticide purchasers and users are exempt from the regulations of this Act but these exemptions may be removed in the near future.

ONTARIO LEGISLATION

Transportation of pesticides is regulated under Sections 105, 106, 107 and 108 of the Ontario Pesticides Act which states as follows:

No person shall transport or cause or permit the transportation of a pesticide by a vehicle operated on any highway or road unless the pesticide is secured in a manner sufficient to prevent the escape or discharge of the pesticide from the vehicle. (R.R.O. 1980, Reg. 751, s.105)

No persons shall transport or cause or permit the transportation of any Schedule 1, 2, 3, or 5 pesticide together with commodities that are,

a) food or drink intended for human or animal consumption

b) household furnishings; or

c) toiletries, clothes, bedding or similar commodities,

by a vehicle operated on any highway or road unless the pesticide being transported is separated from such commodities in a manner sufficient to prevent their contamination or likely contamination by the pesticide. (R.R.O. 1980, Reg. 751, s.106.)

No person shall transport or cause or permit the transportation of any pesticide in bulk by a vehicle operated on any highway or any road unless the vehicle has a warning sign prominently displayed on and affixed to the outside of the vehicle warning of the presence of the pesticide. (R.R.O. 1980, Reg. 751, s.107.)

1) A person who uses, stores, displays, sells or transports a pesticide which is a machine, apparatus, equipment, article, instrument, contrivance or gadget which does not utilize any,

   a) Schedule 1, 2, 3, 4, 5 or 6 pesticide; or

   b) chemical or microbiological agent,

is exempt from the Act and regulations thereunder.

2) A persons who uses, stores, displays, sells or transports a pesticide that is registered under the **Pest Control Products Act** (Canada) for use only in the extermination of microorganisms and that is not classified under this Regulation is exempt from the Act and regulations. (R.R.O. 1980, Reg. 751, s.108.)

CONSIDERATIONS FOR TRANSPORTATION

Persons transporting pesticides must carefully inspect each container prior to accepting it for transportation to ensure that there are no broken bags, cartons or leaking liquid containers. Such containers must not be accepted for transportation. Containers must be loaded in such a manner to prevent breakage and movement of the containers during transit.

Liquid containers in particular must be secured and stacked in such a manner to ensure they do not move during transit. Movement can result in breakage of the containers and spillage of the product, resulting in contamination of other pesticides and the vehicle itself. If contamination of other pesticide containers should occur, the contaminated products should not be used but returned to the manufacturer for disposal or repackaging.

If spillage should occur during transportation, the contaminated vehicle should be cleaned and decontaminated as covered in the section on "Accidents in the Storage".

If a closed vehicle is involved, open all doors to ensure maximum ventilation before entering the vehicle to examine or remove its contents. When spills occur ensure that all persons involved wear the recommended clothing and safety equipment before entering the vehicle. When spills that have the potential to harm man or the environment do occur they must be reported to the Spills Action Centre 1-800-268-6060.

Other agencies which may be contacted are:

The local Ontario Ministry of the Environment office;

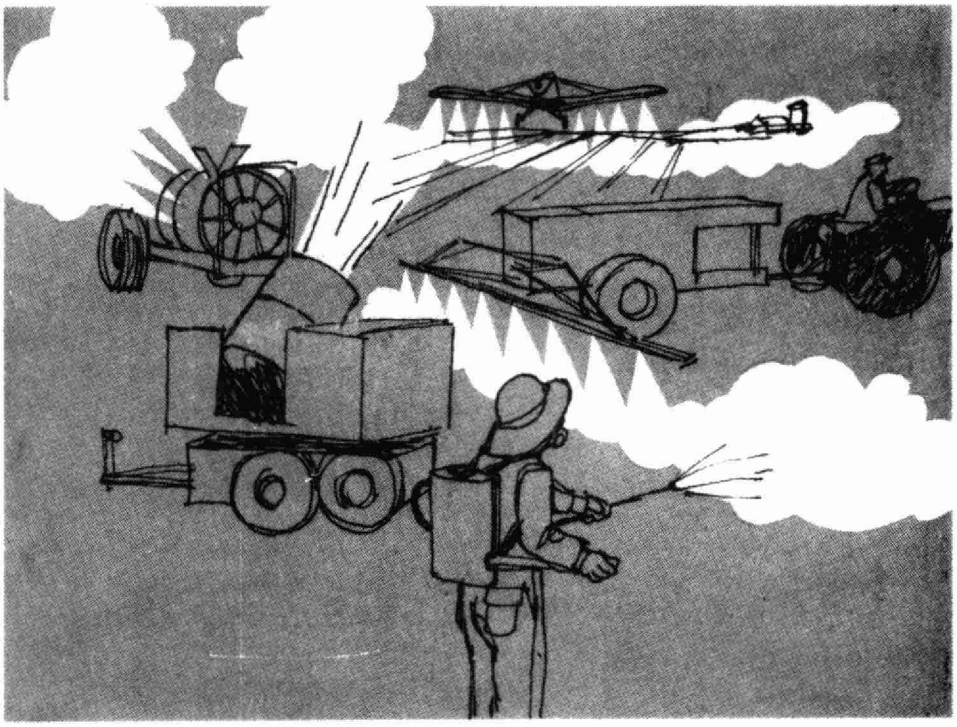
CANUTEC - Canadian Transport Emergency Centre,
Transport Canada
(613) 996-6666

Call collect for information on chemicals, toxicological properties, health hazards, first aid, remedial action, etc.

If spills occur as the result of a highway accident, local fire and police departments should be notified immediately.

APPLICATION EQUIPMENT

A wide variety of equipment is available for applying pesticides. Application equipment can be simple, such as hand-held squirt bottles or complex, such as multiple-nozzle pressure sprayers. Factors to be considered in selecting equipment include the size and type of area to be treated, the type of pest, the pesticide formulation and the required application accuracy. It is important to select suitable equipment and to maintain the equipment to ensure effective pesticide application.



This section reviews the principal types of application equipment and describes basic sprayer parts and maintenance.

HAND-OPERATED SPRAYERS

Hand-operated sprayers are often used to apply small quantities of pesticide. Most are operated with compressed air which is supplied by a hand-pump. They are commonly used in spot spraying. The disadvantages of hand-operated sprayers are that pressures and output rates usually fluctuate. They often do not provide sufficient agitation to keep wettable powders in suspension. Some examples of hand-operated sprayers include the following:

Pressurized Cans (aerosols)
Small non-reusable cans with a capacity of less than 1 L are available for home use.

Pressurized Cylinders
Large reusable cylinders for aerosol generation are available for structural, agricultural crop and greenhouse pest control.

Trigger Pump Sprayers ("squirt gun" sprayer)
The pesticide container is not pressurized. Instead, the pesticide and carrier are forced through the nozzle by pressure created when the trigger is squeezed.

Hose-end Sprayers

A vacuum draws a fixed rate of pesticide from a small spray tank, to mix with water flowing through a hose. The spray-tank usually holds concentrated pesticide. Such sprayers may deliver 50 L or more of spray solution before they need refilling. The major disadvantage with these sprayers is that any dirt in the nozzle can change mixing ratios and make them unreliable.

Compressed-air Sprayers

(Figure 11-1). This type of sprayer operates under pressure, usually supplied by a manual pump which fits into the top of the spray tank. Compressed air above the spray mixture forces the liquid out of the tank through a hose and nozzle. Such sprayers may be hand-held (capacity 4 to 10 L) or back-pack units (capacity up to 25 L). Some compressed-air sprayers are equipped with pressure gauges for accurate pressure control. Some nozzles are equipped with a shutoff at their tip to avoid dripping when spraying is stopped. Operating pressures for hand-operated sprayers are usually between 100 and 600 kPa.

Another type of compressed air sprayer uses a precharged cylinder of air or carbon dioxide to provide pressure. These units include a pressure-regulator valve to maintain uniform spray pressure. Pesticides may be applied through a handgun or a short boom.

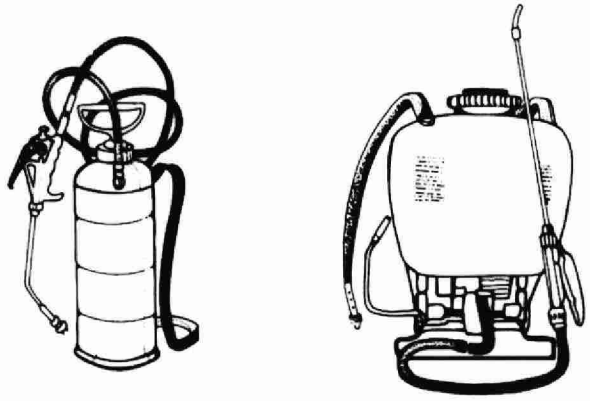


Figure 11-1

Push-pull Hand Pump Sprayers

A hand-operated plunger forces air out of a cylinder creating a vacuum at the top of a siphon tube. The suction draws pesticide from the tank and forces it out with the air flow. This type of sprayer ranges in size from hand-held (capacity 1 L) to wheelbarrow sprayers with up to 100 L capacity tanks and a long spray hose.

Bucket or Trombone Sprayers

A double-action hydraulic pump is operated with a push-pull motion. The pump is used to apply liquid pesticides from a separate container. The pesticide is sucked into a cylinder and pushed out through the hose and nozzle with each stroke. Pressure up to 1,000 kPa can be obtained. The pesticide container often consists of a bucket with a capacity up to 20 L.

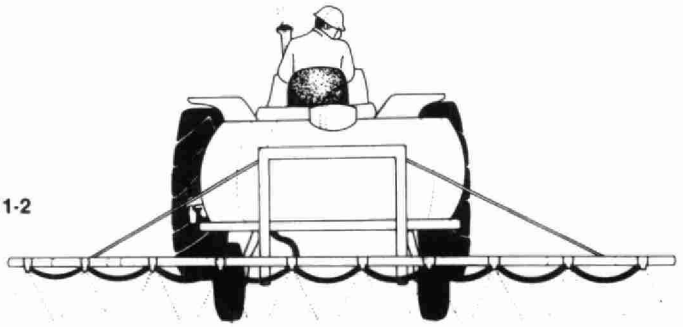
MOTORIZED SPRAYERS

These spray units typically use a power-driven pump to provide pressure to the pesticide in the hose rather than in the tank. These systems can be mounted on tractors, trucks, trailers or aircraft. They may be low-pressure or high-pressure types according to the pump and other components they contain. Some examples include:

Low-pressure Boomless Sprayers
These sprayers come in a wide variety of sizes. Working pressures are usually less than 500 kPa. They may be mounted on skids for carrying in small trucks or mounted on a trailer for pulling manually or with a vehicle. They may be equipped with a hose and a handgun with an adjustable nozzle for spot treatments or may have a central nozzle cluster that produces a wide spray swath for broadcast treatments.

Low-pressure Boom Sprayers
(Figure 11-2). These sprayers are designed to distribute pesticide solutions over large areas. They are most often used in agricultural, forestry and rights-of-way pest control operations. They are used to deliver low to moderate application rates, usually from 50 to 500 L/ha, at working pressures ranging from 150 to 500 kPa. The most common booms are between 6 and 10 m long and contain nozzles spaced at 50 to 100 cm intervals.

Figure 11-2



High-pressure Sprayers
These sprayers are used to spray through thick foliage, to the tops of trees and into other areas where high-pressure sprays are necessary for adequate penetration. Often called hydraulic sprayers, they can develop pressures up to 7,000 kPa. These units must be heavy-duty to withstand the high pressures. Such sprayers can be fitted with a boom and multiple nozzles, or a hose and single handgun nozzle for use in spraying individual trees or livestock.

Air-blast Sprayers
A combination of air and liquid is used to deliver the pesticide to the surface being treated (Figure 11-3). The pesticide is pumped through nozzles into a blast of air from a high-speed fan. The pesticide is broken into fine droplets and carried to the target. These sprayers can usually be adjusted to apply high or low volumes of spray at a wide range of pressures. Normally, the spray mixture requires mechanical agitation. Drift can be a problem with the fine spray produced from these sprayers.

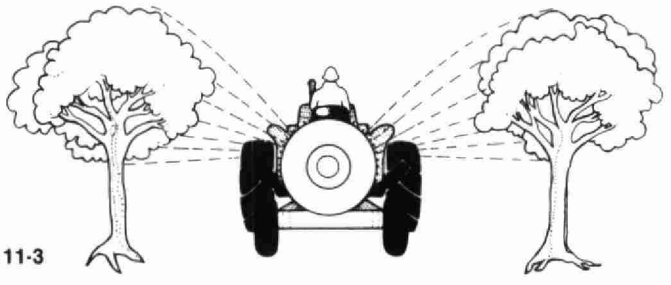


Figure 11-3

Low-volume Air Sprayers (mist blowers)
These sprayers are characterized by high air velocities to break up the liquid into droplets. They use low water volumes and operate at lower pressures than conventional air-blast sprayers.

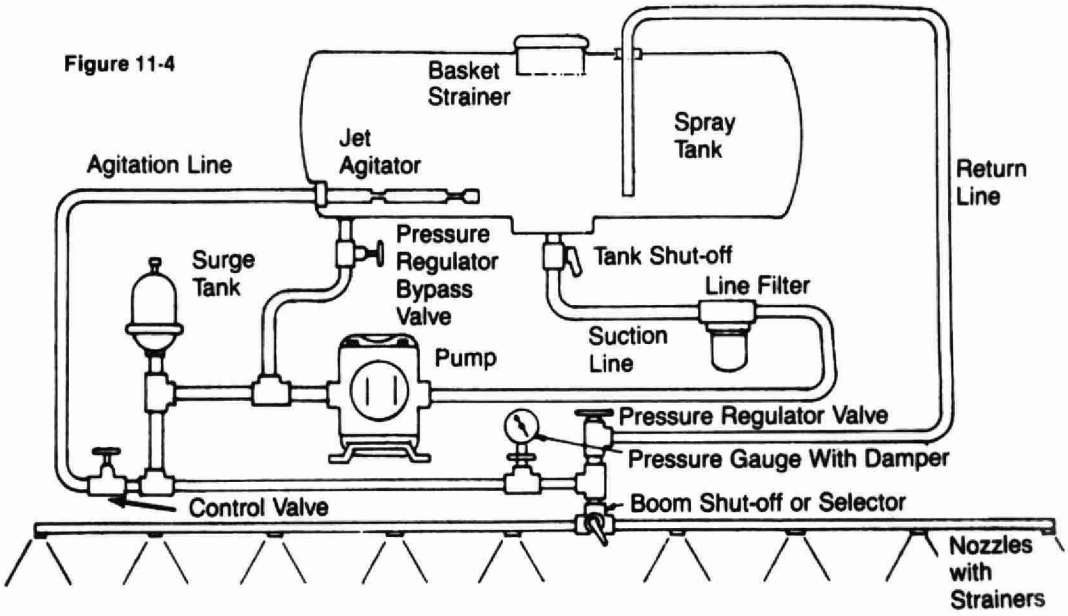
Ultra-low Volume (ULV) Sprayers

These sprayers apply special pesticide concentrates with little or no water or other liquid carrier. Droplet sizes are smaller but droplets are more numerous than in conventional sprays. Application rates are only 5 to 6 L/ha or less. They save time by eliminating the need for mixing, but the applicator is at greater risk. Only a few pesticides are registered for ULV application.

SPRAYER PARTS AND SPRAY OUTPUT

Various components of a typical low-pressure boom spray system are illustrated in Figure 11-4. Some characteristics of these components are given below.

Figure 11-4



SPRAY TANKS

Tanks should have a large, screened opening for easy filling and cleaning. They should have a large drain plug, located so the entire tank can be drained. Tanks should be made of corrosion-resistant material for the pesticides used. Some pesticides known to cause corrosion or deterioration of certain materials are listed in Table 11-1. For accurate mixing of pesticides, the amount of spray held by a full tank should be known.

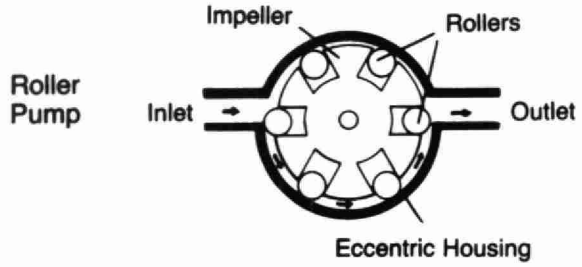
Table 11-1. Spray tank susceptibility to corrosion or deterioration from various pesticides.

Spray Tank Material	Pesticides Causing Corrosion or Deterioration
galvanized steel	acidic formulations and pesticides such as Bordeaux mixture, carbophenothion, chlorfenvinphos, 2,4-D, dalapon, difenzoquat, endosulfan, glyphosate (may produce explosive hydrogen gas), mevinphos, paraquat, phosphamidon
aluminum	difenzoquat, paraquat, dichloropropenes
polyethylene	EPTC, methoxychlor and TEPP (also sunlight)
fibreglass	generally resistant
stainless steel	generally resistant

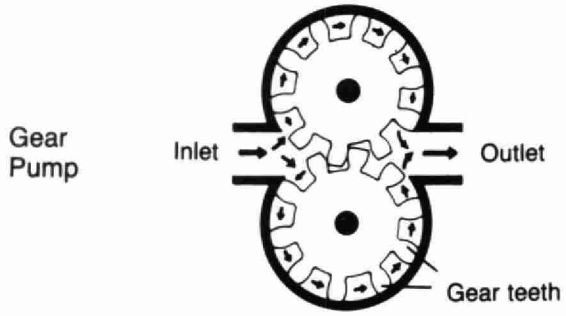
The pump must have sufficient capacity to supply the needed volume to the nozzles and to the hydraulic agitator (if necessary) and to maintain the desired pressure. The pump components should be resistant to corrosion and abrasion if materials such as wettable powders are to be used. Gaskets, plunger caps and impellers should be resistant to the swelling and chemical breakdown caused by many liquid pesticides.

A sprayer pump should not be operated at speeds or pressures above those recommended by the manufacturer. Pumps will be damaged if run dry or with a restricted inlet or outlet. Pumps depend on the spray liquid for lubrication and cooling. Some pump types include the following:

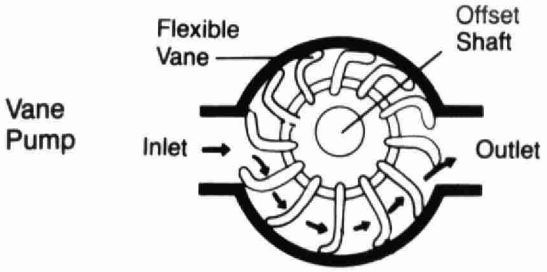
Roller Pumps
Roller pumps are among the least expensive and most widely used of all sprayer pumps. They provide moderate volumes (100 to 300 L/ha) at low to moderately high pressures (100 to 2,000 kPa). Roller pumps are positive-displacement, self-priming pumps and are often used on low-pressure sprayers. The rollers, made of nylon, teflon or rubber, wear rapidly when used for wettable powders but are replaceable. A pump that will be subject to rapid wear should have a capacity about 50% greater than that required when the pump is new. Roller pumps are best for emulsifiable concentrates, soluble powders and other non-abrasive pesticide formulations.



Gear Pumps
Gear pumps are used on sprayers with low operating pressures. They provide low to moderate volumes (50 to 100 L/ha) at low to moderate pressures (150 to 700 kPa). Gear pumps are positive-displacement, self-priming pumps. The self-priming ability is rapidly lost as the pump wears. These pumps are designed for oil solution formulations and wear rapidly when suspensions of wettable powders are used. The parts are generally not replaceable. The pump is not affected by solvents, since all parts are metal.

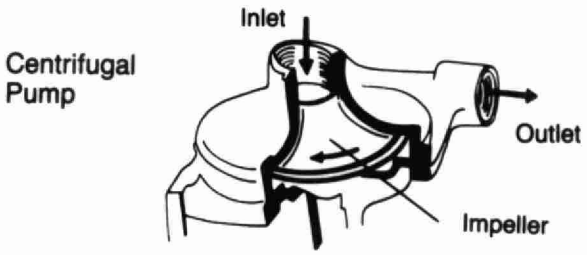


Vane Pumps
Vane pumps are similar to roller pumps. They provide moderate volumes (100 to 300 L/ha) at low pressures (to 350 kPa) and can be used with wettable powders.



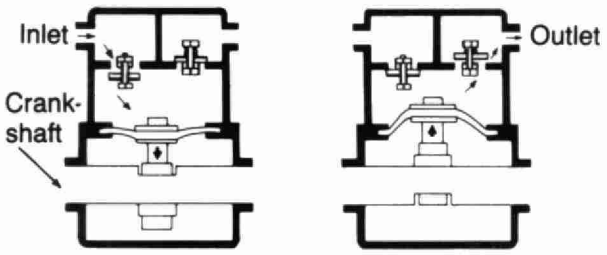
Centrifugal Pumps

Centrifugal pumps are relatively inexpensive pumps adaptable to a wide variety of spray applications. Generally, they deliver high volumes (up to 2,000 L/ha) at low to moderate pressures (50 to 350 kPa); however, two-stage centrifugal pumps develop higher pressures (up to 1,400 kPa). They are used on agricultural sprayers, commercial spray-dip machines and other equipment. Centrifugal pumps are not positive-displacement pumps, so pressure regulators and relief valves are only necessary if spray pressure is to be regulated. They are not self-priming and must be mounted below the tank outlet or with a built-in priming system. Centrifugal pumps are well adapted for spraying abrasive materials because the impeller does not contact the pump housing. Many models are easily repairable.



Diaphragm Pumps

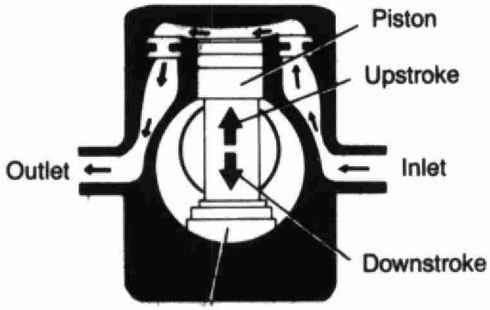
Diaphragm pumps are available with low, medium and high flow and pressure capabilities. They are excellent for use with abrasive spray mixtures. High pressure diaphragm pumps are now more popular than piston pumps. Maintenance costs are low in comparison with piston pumps of the same capacity. Diaphragm pumps may require a surge tank to dampen pressure surges.



Diaphragm Pump

Piston Pumps

Piston pumps deliver low to medium volumes (20 to 650 L/ha) at low to high pressures (150 to 5,500 kPa). They are used for high-pressure sprayers or when both low and high pressures are needed. They are positive-displacement, self-priming pumps. A surge tank should be used to dampen pressure surges. They are abrasion-resistant and capable of handling wettable powders for many years, although maintenance costs may be high.



Piston Pump

AGITATORS

Every sprayer must have agitation to keep the spray material uniformly mixed. If there is too little agitation, the pesticide will be applied unevenly. If there is too much agitation, some pesticides may foam and interfere with pump and nozzle operation. The type of agitation required depends on the pesticide formulation used. There are four main types of agitation:

Manual Agitation
Manual agitation by means of a paddle or continuous shaking may suffice for small hand-operated sprayers, but it is not practical for powder sprayers.

Mechanical Agitation
Mechanical agitation is obtained with paddles attached to a shaft mounted near the bottom of the spray tank. This type of agitation assures proper mixing with all liquid spray formulations. Careful maintenance of the spray equipment is necessary to prevent premature wear of the agitator shaft bearing which could result in pesticide leakage through the packings or seals.

Excessive agitation speeds can cause foaming in some spray mixtures.

Hydraulic Agitation
Hydraulic agitation is obtained when a portion of the pump output is returned to the tank. The simplest and least effective method is by return line from the pressure regulator valve (return-line agitation). This type of agitation is practical only with emulsifiable and water-soluble pesticide formulations. It is not suitable for wettable powders or in tanks larger than 250 L unless a high-capacity centrifugal pump is used.

A second type of agitation is provided by the high-pressure flow of surplus spray material through a separate agitator line into the spray tank. The liquid flows through jet agitators positioned at the bottom of the spray tank. Jet agitators are not to be attached to the pressure regulator valve return line as this will cause irregular valve operation. Hydraulic agitation is less troublesome than mechanical agitation and seldom causes mechanical breakdown.

Air Sparging
Air sparging is agitation by bubbling air through the liquid. A compressor supplies air which is discharged from a sprayer tube at the bottom of the tank. As bubbles of air rise to the surface, they create turbulence which keeps the fluid well-mixed.

PIPES AND HOSES

Suction hoses (drawing from the tank) should be reinforced so that they will not collapse. Suction hose diameters should be at least as large as the pump intake opening. The same type of hose can be used for the bypass line.

Hoses and fittings on the pressure side of the pump must be able to handle pressures higher than the intended operating pressures, preferably as high as the maximum pressure the pump can develop, to withstand pressure surges.

The inner and outer layers of all hoses should be resistant to chemical deterioration by the pesticides used.

PRESSURE GAUGES

The gauge is mounted on the output side of the pump to provide the operator with a visual guide in controlling pressure. Pressure gauges should have a pressure range which is at least twice the expected operating pressure. The gauge should have a pulsation damper to smooth pressure surges from piston pumps.

PRESSURE REGULATOR VALVES

The pressure regulator controls the pressure and, indirectly, the quantity of spray material delivered by the nozzles. It also protects pump seals, hoses and other sprayer parts from damage due to excessive pressure.

The return line from the pressure regulator to the tank should be kept fully open and unrestricted and should be large enough to carry the total pump output without any pressure buildup. The pressure range and flow capacity of the regulator must match the pressure range and the capacity of the pump. Jet agitation devices should not be attached to the return line discharge. Regulators include the following types:

Throttling Valves

Throttling valves restrict pump output, depending on how much the valve is open. These valves are used only with centrifugal pumps, whose output is very sensitive to the amount of restriction in the output line.

Diaphragm Pressure Regulator Valves

Diaphragm pressure regulator valves open or close in response to changes in pressure, diverting various amounts of spray back to the tank to keep pressure constant. Generally their use is confined to the lower pressure ranges, where they will regulate pressures more accurately than other types. They are abrasion resistant and may be used with wettable powders, flowables and suspensions. However, the diaphragm material must be resistant to the pesticides used.

Pressure Regulator Valves with Spring-loaded Check Valves

Pressure regulator valves with spring-loaded check valves operate like diaphragm valves and are available in many pressure ranges. At low pressures, their performance is less accurate than diaphragm pressure regulator valves.

Pressure Regulator Unloader Valves

Pressure regulator unloader valves work like a spring-loaded regulator valve when the sprayer is operating and remain open when the nozzles are shut off. They are recommended where high pressures (over 1,300 kPa) are frequently used. High pressures put heavy strains on both the motor and pump. Each time the nozzles are shut off, a pressure surge occurs in the pressure lines. This pressure surge triggers the unloader valve, allowing the spray mixture to return, under low pressure, to the spray tank. Consequently, both the motor and pump are relieved of strain each time the delivery system is shut off. When the boom shut-off valve is opened, a drop of pressure in the pressure line opens the pressure unloader valve.

Pressure Regulator Bypass Valves

Some sprayers are now equipped with pressure regulator bypass valves to relieve pressure when starting the pump. As the name indicates, this valve allows the spray mixture to bypass the pressure regulator valve and return, under little pressure, to the spray tank. The bypass valve should be installed on the pressure side of the pump, with a return line to the spray tank. If a sprayer has a pressure unloader valve, a bypass valve is not required.

FILTERS

Filters are essential on all spray equipment. Improper filtering results in costly wear and tear on spray pumps, pressure regulators and nozzle orifices. Clogged nozzles are often the result of improper filtering and cause much "down time". Filtering devices should be used in the spray tank filler opening, in the suction line and in the pressure line of a sprayer system as follows:

Tank Screens

Tank screens may consist of a funnel with a screen for small sprayers. Larger sprayers often feature a filling hole screen supplied by the manufacturer. Filtering at this stage removes only the coarsest contaminants. Smaller abrasive particles pass through this screen.

Suction Line Filters

Suction line filters may be installed as a "foot screen" attached to the end of the suction line inserted through the top of the spray tank. This system prevents excess contaminants on the bottom of the spray tank from reaching the pump, but spray mixtures can never be entirely removed from the spray tank, except by draining. This will constantly present a pesticide disposal problem. A better method of filtering at this stage is the use of a large area "in-line" suction filter. In this method, the suction line may be attached to and drain the bottom of the spray tank. No residue will remain to be flushed from the tank bottom. Suction line filters are usually 20 to 50 mesh*, depending on the pesticide formulation used.

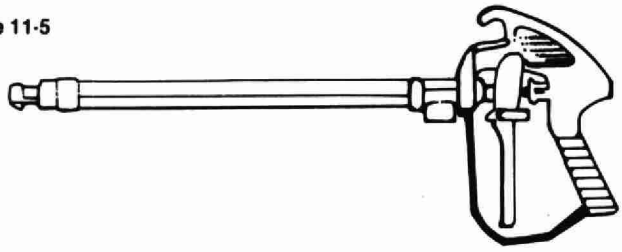
Pressure Line Filters

Pressure line filters are available as "in-line" filters and nozzle screens. Pressure line filters may be used in addition to suction line filters but should never replace them. Pressure in-line filters with a 100 mesh screen are often helpful when very small nozzle orifices are used. Nozzle screens or strainers are required for all power-operated sprayers. Manufacturer's recommendations should be adhered to. These screens usually vary from 50 to 200 mesh.

SPRAY GUNS

Spray guns (Figure 11-5) are available in a wide variety of models and sizes. On many hand sprayers, smaller power sprayers and mist blowers, the spray gun is either an integral part of the sprayer or is supplied as standard equipment. Spray guns may consist of a shut-off valve and a nozzle in two distinct parts or both functions may be integrated in one adjustable unit. Spray guns are made of plastic, brass, aluminum or stainless steel, or combinations of these materials. Choice of material depends on the pesticide spray mixture and pressure used, as well as the frequency of use. A spray gun should be selected to match the sprayer operating pressure. Some guns are rated for pressures between 200 and 5,000 kPa, while others may be rated for pressures less than 1,500 kPa, or a different pressure range. Spray gun nozzles must be selected to deliver spray at the appropriate volume, angle and distance. Some nozzles are adjustable to produce patterns ranging from a solid stream to a fine cone spray.

Figure 11-5



*mesh size refers to the number of holes per linear inch of screen

NOZZLES

Sprayer nozzles serve three important functions:

- they break the liquid into droplets
- they spread the droplets in a specific pattern
- they help regulate the rate of sprayer output

Most sprayers use interchangeable nozzles. There are many types of nozzles with different combinations of output capacity, spray pattern and operating pressure.

Most nozzles are composed of four parts: the nozzle body, the strainer (screen), the tip and the cap (Figure 11-6). Some nozzles, called swirl nozzles or disc-core nozzles, include a swirl plate (core) between the strainer and an orifice disc which helps regulate droplet size. Swirl nozzles are used on air-blast sprayers.

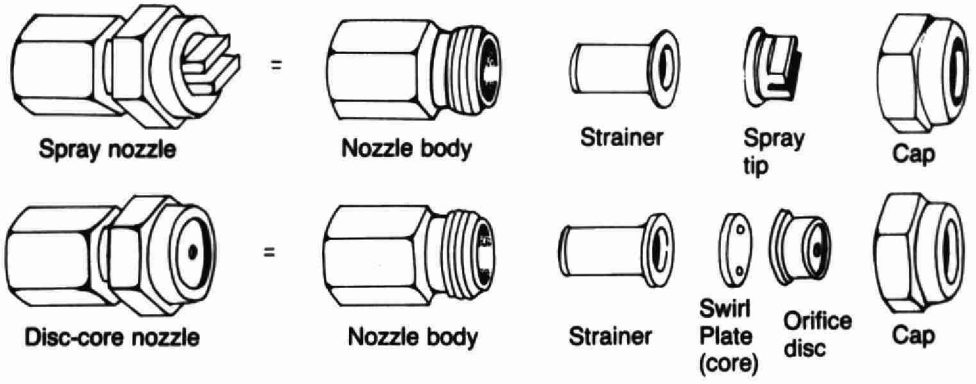


Figure 11-6

The nozzle body holds the strainer and tip in proper position. Several types of tips that produce a variety of spray patterns may be interchanged on a nozzle body made by the same manufacturer. The cap is used to secure the strainer and the tip to the body. The cap should not be over-tightened. The nozzle screen or strainer is placed in the nozzle body to filter out debris which may clog the nozzle opening. Screens come in mesh sizes from 20 to 200. The screen must have a mesh smaller than the nozzle orifice. Screens should not be finer than 50 mesh when wettable powders are used. A slotted strainer is often used in place of a screen for larger nozzle openings and cone pattern nozzles.

In some spraying operations, it is desirable to have a quick shut-off at each nozzle to prevent dripping. Special strainers equipped with check-valves are available for this purpose. A diaphragm or ball closes the nozzle opening when the pressure drops below a specified level. These diaphragm or ball check-valves may be used when turning a sprayer at the ends of rows or for spot spraying near sensitive crops.

Nozzle tips are made from a variety of materials. Choice of materials depends on the abrasiveness of the spray mixture used. Wettable powders are more abrasive than emulsions. The nozzle materials below are listed in order of **increasing** rate of wear:

Alumax, Kemetal, Ceramic	Slow wear
↓	↓
Nylon	Slow wear
↓	↓
Stainless Steel	Slow wear
↓	↓
Brass	Rapid wear

Alumax, Kemetal and ceramic nozzles are expensive but they will likely outlast the rest of the sprayer. Nylon and stainless steel nozzles will give acceptable wear with most chemicals but each nozzle should be regularly checked for proper flow

delivery. Brass tips are among the least expensive but the metal is soft and the tips wear very quickly. As nozzle tips wear out, their spray pattern changes and rate of application increases. Tests have shown that wettable powders wear some nozzle tips sufficiently to increase the rate as much as 12% after spraying only 20 ha. If the flow from an individual nozzle varies from the manufacturer's specifications by more than 15%, the nozzle should be replaced. Likewise, if any nozzle varies from the sprayer's average nozzle output by more than 5%, it should be replaced.

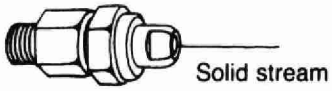
There are a number of different nozzle manufacturers. Tests of different makes of nozzles have shown that some new nozzles produce unacceptable patterns, i.e. incorrect size and shape and uneven spray. Spray patterns can also change as nozzles wear. Nozzles must be replaced if spray patterns are incorrect.

NOZZLE SPRAY PATTERNS

Spray nozzles are described according to the shape of the application pattern. There are six common patterns. Each nozzle type is available in various flow capacities and spray angles and is suited to a particular type of operation.

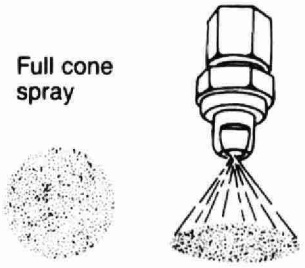
Solid Stream Nozzles

Solid stream nozzles are used in handgun sprayers to spray distant or specific targets such as livestock, nursery or tree pests. When using a pin stream nozzle, it is usually desirable to keep the pressure below 150 kPa to reduce splashing.



Full or Solid Cone Nozzles

Full or solid cone nozzles are used to obtain thorough plant coverage, often required for row crops. They are available as regular or disc-core nozzles. Full cone nozzles are most often used to apply fungicides or insecticides to foliage. They are used for high volume applications where dense foliage requires a penetrating spray. They are frequently used on boom drop pipes or pendants to provide coverage of both sides of leaf surfaces. The spray angle may be from 30° to 120°.

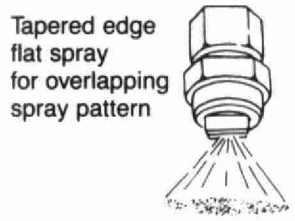


Hollow Cone Nozzles

Hollow cone nozzles are used for agricultural crop spraying, particularly for spraying wettable powders, flowables and suspensions at higher pressures. They are available as regular or disc-core nozzles and are frequently used on boom drop pipes. Disc-core nozzles wear better than regular nozzles when abrasive wettable powders are used. Hollow cone nozzles generally produce a finer, more uniform spray than solid cone nozzles.

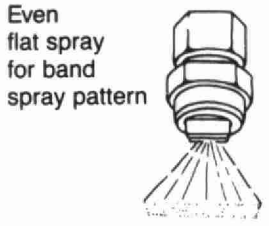
Tapered Edge Flat Fan Nozzles

Tapered edge flat fan nozzles make a narrow oval pattern with tapered ends. They are used for broadcast herbicide and insecticide spraying at pressures between 100 and 400 kPa. The pattern is designed to be used on a boom and to be overlapped 30 to 100 percent. Spacing on the boom, spray angle and boom height determine proper overlap and should be carefully adjusted.



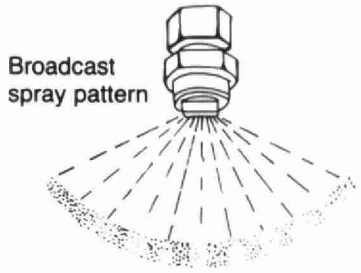
Even Flat Fan Nozzles

Even flat fan nozzles make a narrow oval pattern with a relatively sharp cutoff at the edge of the pattern. They are used for band spraying. Boom height and nozzle spray angle determine the width of the band sprayed.



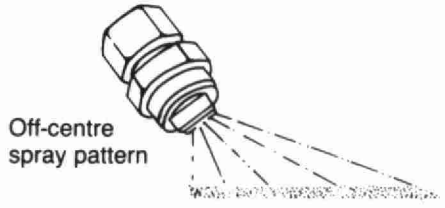
Flooding Nozzles

Flooding nozzles deliver a wide flat spray (up to 135° wide). They are usually operated at low pressures to produce large droplets. Flooding nozzles can be mounted in various positions to produce different patterns. The most uniform application occurs when the nozzle tip is mounted 45° above the horizontal. Flooding nozzles are most often used for broadcast applications and are sometimes used alone for boomless broadcast spraying.



Off-centre Nozzles

Off-centre nozzles produce a wide flat spray which is off to one side of the nozzle. The spray is relatively uniform along its width. They are often mounted on the side of trucks or short booms for spraying along roadsides or irrigation ditches.



NOZZLE FLOW RATES

Nozzle flow rate depends on the size of the nozzle orifice and the spray pressure. With most nozzles, flow rate increases as pressure increases. However, pressure must be increased considerably to achieve a small increase in flow rate. Pressure must be increased four times to double the flow rate. Tables of nozzle flow rates at various pressures are supplied by manufacturers. These tables are developed by measuring the flow rate of water. When other liquids are used, such as more dense or viscous liquids, the flow rates will be different. This is one reason why sprayers must be calibrated for each type of liquid applied.

Volume of spray to be applied per unit area is usually specified on pesticide product labels. For spraying agricultural crops with boom sprayers, herbicides are usually applied at 300 to 500 L/ha and fungicides and insecticides may be applied at 100 to 1,000 L/ha. Some treatments, such as for control of cabbage root maggot or potato late blight, require drenches of at least 1,000 L/ha.

Various categories of spray volumes for air-blast orchard sprayers are listed in Table 11-2. Most fruit tree pests and diseases can be controlled with low-volume air-blast sprays. High-volume air-blast spraying is characterized by considerable spray runoff which may be desirable for control of such bark pests as San Jose and European fruit scales.

Table 11-2. Categories of spray volumes for air-blast sprayers.

Category	Spray Volume
Ultra-Low Volume (ULV)	5 to 6 L/ha or less.
Low Volume Spraying (concentrate spraying)	Usually 550 to 850 L/ha, but may be as low as 100 L/ha. No runoff occurs.
Medium Volume Spraying	1,000 to 2,250 L/ha. Spray droplets flow together on the sprayed surface. Little or no runoff occurs.
High Volume Spraying	2,250 to 5,500 L/ha. Considerable runoff occurs.

SPRAY DROPLET SIZE

A nozzle produces a range of droplet sizes from very small to large. Droplet size is measured in microns. One micron is one millionth of a metre; one thousandth of a millimetre. Average droplet sizes for various types of sprays are listed in Table 11-3.

Table 11-3. Typical droplet size ranges for various pesticide applications.

Category	Average Droplet Size in Microns	Examples of Uses
Fog	0.1 - 50	Thermal fog for greenhouse and structural pest control
Aerosol	1 - 50	Mosquito adulticiding by ground equipment, ultra-low volume applications
Mist	50 - 100	High-pressure sprays
Fine Spray	100 - 250	Cone and fan nozzles used for low-volume applications and air-blast sprayers
Medium Spray	250 - 400	Cone and fan nozzles for moderate-volume low toxicity sprays requiring good coverage
Coarse Spray	400 - 600	Cone and flood nozzles for large-volume and more toxic sprays
Minimum Drift Jet Stream Nozzle Spray	600 - 900	Aerial application near sensitive areas
Low Turbulence Nozzle Spray	800 - 1000	Microfoil boom applicator for aerial spraying near sensitive areas.

The number of fine droplets increases as spray pressure is increased. At low pressures of about 135 kPa, low volume spray nozzles produce very few fine droplets (about 15% by volume). The proportion of fine droplets in the spray increases rapidly as pressure is increased over 200 kPa. At pressures of 400 kPa, the spray consists of about 75% fine droplets. Air-blast sprayers produce a finer spray than boom sprayers for similar pressures and spray volumes. This is because the airstream which carries the spray to the target breaks up the droplets after they leave the nozzles.

The smaller the average diameter of droplets, the better the potential coverage will be for a given volume of pesticide spray (Table 11-4). However, the smaller the droplets, the greater will be the potential for spray drift. Fine droplets are easily diverted from the target by wind currents and evaporation. In order to increase coverage, it may be better to increase the volume of spray by changing nozzles, rather than increasing spray pressures to produce smaller droplets.

Table 11-4. Droplets per square centimeter when 25 L is evenly distributed over 1 ha.

droplet in diameter in microns	number of droplets per cm^2
50	4,000
100	500
200	60
300	20
500	4

Generally, nozzle pressures should never be higher than necessary. For most applications, pressures ranging between 140 kPa and 350 kPa will produce adequate droplet sizes. Herbicides are generally applied within the range of 150 to 275 kPa to keep drift to a minimum. Insecticides and fungicides applied to vegetation often require higher pressures (300 to 2,000 kPa) to obtain thorough coverage and penetration of foliage. Different nozzle arrangements may require different pressures. A drop pendant boom (Figure 11-7) may require pressures of 500 to 1,000 kPa while a simple flat boom would require pressures of up to 1,700 kPa to obtain the same leaf coverage. If ball check strainers or diaphragm check valves are used, pressure must be increased by 35 or 48 kPa respectively.

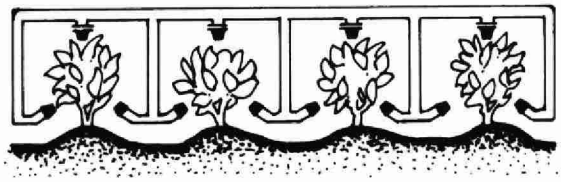


Figure 11-7. Schematic drawing of drop pendant spray boom for applying fungicides and insecticides to potatoes and cole crops. Note use of three nozzles for each row of plants.

CARE OF SPRAY EQUIPMENT

CLEANING

A sprayer should be cleaned before initial use when new, after each day's use, when changing pesticides and before off-season storage. New sprayers may contain metallic chips and dirt from the manufacturing process. Remove the nozzles, flush the sprayer with clean water and clean all screens and nozzles.

After each days use, flush the sprayer tank, pump and hoses with clean water, clean the filter, screens and nozzles. Drain the tank and allow it to dry. Use a toothbrush or other soft material to clean a nozzle tip. Never use a piece of wire, a nail or other metal object because these will damage the orifice, distort the spray pattern and increase the nozzle's output.

If a spray mixture is spilled on the machine during loading or mixing, the outside of the machine should be decontaminated immediately. Wash the contaminated area with soap (or mild detergent) and water, followed with a thorough rinse with plenty of water.

A sprayer should be thoroughly cleaned before use of a different pesticide or before off-season storage. Some pesticides such as 2,4-D are particularly persistent in the sprayer and must be removed completely to prevent possible crop damage during other spray operations. For thorough removal of most pesticides, the following procedure is recommended.

1. Put on rubber gloves, boots, hat, apron and goggles to avoid contact with pesticides during cleaning operations.

2. Wash the outside of the sprayer with soap (or mild detergent) and water, followed by a complete rinse with water. A steam cleaner can be used if available. Compacted deposits can be removed with a stiff bristle brush.

3. Remove all screens and nozzle tips and clean in kerosene or a detergent solution using a soft brush.

4. Mix about 200 g of detergent with 100 L of water in the tank. Circulate the mixture through the bypass for 30 minutes, then flush it out through the boom (when oil is used as the pesticide carrier, petroleum based solvents must be used instead of detergent solution).

5. Replace the screens and nozzle tips.

6. Fill the tank about one-third to one-half full of water then add 1 L of household ammonia or 200 mg of washing soda or 0.5 kg of Nutrasol to each 100 L of water. Circulate the mixture for five minutes, allowing some to go out through the nozzles. Keep the remainder of the solution in the system overnight, then run it out through the nozzles the following morning.

7. Flush the system with a tankful of clean water by spraying through the boom with nozzles removed.

8. When the pump is not in use, fill it with light oil and store it in a dry place. If the pump has grease fittings, lubricate them moderately from time to time. Over-lubrication can break seals and cause the pump to leak.

9. Remove nozzles and screens and place them in light oil for storage.

10. Drain all parts to prevent frost damage.

11. Cover openings so that insects, dirt and other foreign material cannot get into the system.

12. Store the sprayer, hoses and boom in a dry storage area.

A number of pesticide spray mixtures have a tendency to penetrate the materials used for hoses, packings and gaskets. Therefore, if at all possible, do not use equipment which contained herbicides to apply insecticides or fungicides. If the same equipment must be used for herbicides and other pesticides, hoses should be kept separate as a minimum precaution.

All rinse water from cleaning application equipment must be disposed of in a way that will not contaminate the environment. See guidelines for disposal in Disposal Section.

MAINTENANCE

Proper equipment maintenance is essential for economic reasons, environmental safety and personal safety. Costs and hazards of equipment breakdown during pesticide applications are high. Improper maintenance results in:

- accidents
- spills
- hazards to personal safety
- contamination of the environment
- revenue loss due to "down time"
- costs for replacement parts and labour for repairs
- crop loss

Preventive maintenance starts with the selection of equipment to be purchased. Select equipment that will more than adequately do the job. Overworked equipment wears out quickly.

Pumps

Pumps must have sufficient capacity to provide adequate volume and pressure. Always work the pump at the lowest required pressure and speed. Pressure drops may indicate:

- pump starvation - check suction screens and lines
- valve or piston wear - replace worn parts
- pressure regulating valve is defective - check and repair
- pump volume capacity is inadequate

Screens

Screens of proper mesh and material should be selected for the pesticide formulation used. When selecting line and nozzle screens (filters, strainers) consider the particle size of the spray mixture, i.e. emulsifiable formulations, flowables, suspensions or wettable powders. Pump life will be prolonged and nozzle wear reduced.

Pressure Regulating and Unloader Valves

Pressure regulating and unloader valves must have an adequate volume and pressure capacity. Consider the port diameters and spring capacity. Never start a pump against pressure.

Agitation

Agitation must be selected which is appropriate for the pesticide formulation used, i.e. liquids or wettable powders. Proper agitation ensures even mixing of the pesticide and diluent and reduces pump wear. When using hydraulic agitation with wettable powders, do not stop the pump while spray mix remains in the tank. Mechanical agitation requires additional maintenance but is desirable if wettable powder mixes are used frequently.

Hoses, Fittings and Lines

Hoses, fittings and lines must be adequate for the pressures and volumes sprayed. Excessive sediment or plugged lines may cause pressure drops. Replace worn hoses.

Spray Guns and Nozzles

Spray guns and nozzles should be appropriate for the material. More abrasive spray mixes require harder nozzle materials. Check nozzles regularly for wear. Avoid uneven application by replacing worn nozzles. Use nozzle strainers that match the orifice size.

Other Preventative Measures

Other preventative measures include:

- Overhaul pump yearly in the off-season; keep the pump and sprayer schematic diagram and parts list handy.

- Paint parts of the sprayer which will corrode, but do not paint the inside of the tank.
- Clean out the sprayer after use, especially after using wettable powders. Pesticides left in a sprayer will penetrate into hoses and gaskets, and metal tanks will corrode prematurely.
- Store unused sprayers under cover, drained and rinsed, and leave lid off spray tank.
- Use gaskets and washers of material such as teflon which will not deteriorate from pesticide mixtures.
- Keep spare parts in stock.

AEROSOL GENERATORS AND FOGGERS

Aerosol generators convert special formulations into very small, fine droplets (aerosols). Single droplets cannot be seen, but large numbers of droplets are visible as a fog or mist. Some aerosol generators, known as thermal foggers, use heat to vaporize a special oil formulation of a pesticide. As the pesticide vapour is released into the cooler air, it condenses into very fine droplets, producing a fog. Other aerosol generators (cold foggers) break the pesticide into aerosols by using mechanical methods such as rapidly spinning discs, extremely fine nozzles and high pressure (atomizing nozzles) or strong blasts of air.

This specialized equipment is often used in greenhouses, barns and warehouses as well as for biting fly and mosquito control in outdoor recreation areas. Outdoor use of aerosols is limited due to rapid drift from the target area. There is typically no residual control of pests, but re-entry is safe soon after enclosed spaces have been ventilated. Pesticides used in aerosol generators must be registered for that use. The operator, bystanders and animals must be kept out of the fog or mist.

WICK APPLICATORS

Wick applicators are used to selectively apply liquid herbicide by wiping it onto plants. Wicks are made of rope or absorbent pads and are kept wet by soaking part of the material in a concentrated herbicide mixture. For example, in one type of wick applicator, the herbicide solution is poured into a length of pipe and seeps out through rope segments (Figure 11-8). The herbicide can be wiped selectively onto weeds growing above crop seedlings or between crop rows. Often wick applicators are constructed by applicators to suit their own needs. Pumps, control devices and nozzles are minimal or eliminated and tanks are quite small because of the small amount of herbicide applied. They can be useful where selective weed control is required and no drift can be tolerated.

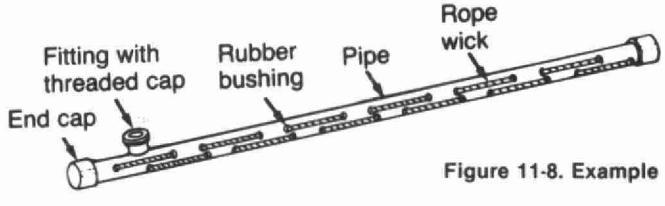


Figure 11-8. Example of a wick applicator.

EQUIPMENT FOR THE APPLICATION OF SOLID PESTICIDE FORMULATIONS

DUST APPLICATORS

Dust formulations may be applied by small or large, hand-operated or motorized dusters. Air is the carrier for the delivery of all dust formulations. Drift, therefore, is an important drawback for dust formulations. Power dusters are used where deep penetration of large areas is required. They are powered by electricity or gasoline and consist of a motor, dusthopper and radial fan. Motorized backpack sprayers

(mist blowers) sometimes feature an optional tank for the application of dusts. Dust applications are not recommended for large-scale operations outdoors due to drift problems, residue problems on edible crops and unsightliness on many ornamental crops and plants. In agriculture, dust applications are mostly used for small spot treatments.

In selecting a power duster, look for a unit which is easy to clean. It should give a uniform application rate as the hopper is emptied. The dust cloud should be directed away from the user.

GRANULE APPLICATORS

Granular formulations are frequently used for large scale applications, specifically for soil applications and when residual action is needed. Unlike spray and dust applications, there is little problem with drift or unsightly residues when granular applications are made. Phytotoxicity is often reduced with granular insecticide applications. Application equipment may be small or large. A hand shaker may be used for small spot treatments. Mechanical applicators distribute granules by means of forced air, spinning or whirling discs (fertilizer spreaders), multiple gravity-feed outlets (lawn spreaders, seed drills), soil injectors (furrow treatments) or ram-air (aircraft application). Granular applications may be described as:

- broadcast - even distribution over an entire area
- spot treatment - hand application, furrow application or side-dressing
- soil incorporation - drilling or soil injection.

Good granular applicators have mechanical agitation over the outlet holes. This prevents clogging and helps keep the flow rate constant. Applicators should stop when forward motion stops, even if the outlets are still open. Application speed should not be too fast for ground conditions. Bouncing equipment will cause the application rate to vary. Band applicators must be checked frequently to see that band width stays the same. For example, band width may change due to applicator wheels sinking into soft soil.

Some limitations of granular applicators include the need to calibrate for each different granular formulation. Also, the spinning disc applicators often give an uneven distribution on sloping ground.

SOIL FUMIGATION EQUIPMENT

The equipment needed for applying soil fumigants depends on the kind of fumigant being used. There are two types of fumigants:

- low--pressure (low volatility) liquid fumigants (dichloropropenes and metam-sodium)
- the highly volatile fumigants (methyl bromide) which remain liquid only under pressure.

LOW PRESSURE LIQUID FUMIGATORS

Equipment for applying low-pressure fumigants uses two basic designs for delivering the required amount of fumigant. These delivery systems are either pressure-fed or gravity-flow.

- Pressure-fed applicators have a pump and metering device and deliver fumigant at pressure to the nozzle openings (orifices), as with a low-pressure sprayer.

- Gravity-flow applicators use the size of the nozzle orifice and the pressure created by gravity to regulate the output of fumigant. Constant speed is necessary to maintain a uniform delivery rate. In most applicators, a constant head gravity-flow device keeps the pressure at the orifice(s) constant as the tank or container of fumigant empties. Needle valves, orifice plates or discs, and capillary tubes are used to adjust the flow rate.

- Low-pressure fumigators usually use soil or water to keep the fumigant from vaporizing and dispersing too quickly. Some of the methods used are soil injection, soil incorporation and drenching or flooding.

- Soil injectors use a variety of mechanisms to place the fumigant into the soil (usually 15 cm or more) and then cover the area with more soil to seal in the fumigant. The principal mechanisms include chisel cultivators, sweep cultivator shovels, planter shoes and plows.

- Soil incorporators are used when applying low-volatility fumigants. The fumigant is usually sprayed onto the soil surface. The area is immediately cultivated, usually to a depth of 15 cm or less, and then compacted with a drag, float or cultipacker. Power-driven rotary cultivators are also used.

- Drenching or flooding uses water as a sealant. The fumigant may be applied in water as a drench, for example, with a sprinkling can or through irrigation equipment. Alternatively, the fumigant may be applied first, by spraying the soil surface, then flooding the area with water. The depth of the required water seal (usually 1 to 10 cm of wetted soil) depends on the volatility of the fumigant.

HIGH-PRESSURE FUMIGATORS

Effective application of highly-volatile fumigants depends on tightly sealing the soil with tarps, plastic film or similar covers. There are two major methods of using vapour-proof tarps:

- tarps are supported off the ground, then sealed around the edges and the fumigant is introduced under the tarp

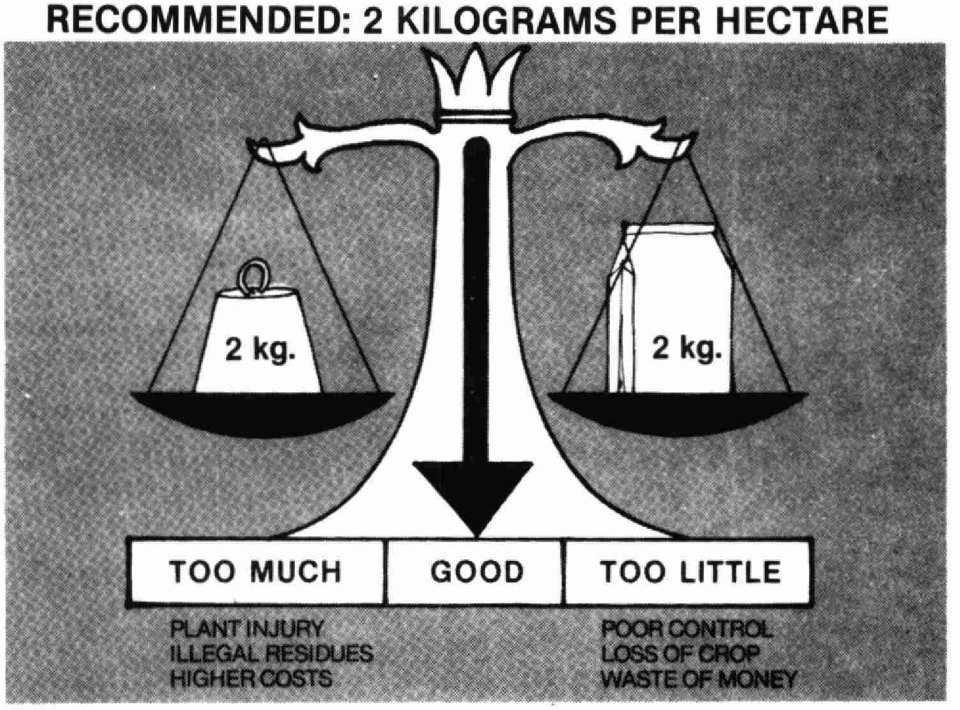
- tarps are applied to the soil by the chisel applicator immediately after the fumigant is injected.

Highly-volatile fumigants must be handled in pressurized containers or tanks. The pressure in the tank maintains the pressure at the nozzle orifices. The tank is either pre-charged with sufficient pressure to empty its contents or an inert pressurized gas is fed into the tank during the application to displace the fumigant. A pressure regulator maintains uniform pressure in the system. The fumigant must be under enough pressure to maintain its liquid state in the tank, pressure lines, manifold and metering devices. As the fumigant is discharged from the nozzles, it becomes a gas.

Extreme caution must be observed when working with fumigants due to the hazard of exposure to the highly toxic gases.

EQUIPMENT CALIBRATION AND CALCULATIONS FOR CORRECT APPLICATION RATES

It is important to select the right pesticide and apply it at the right time for effective pest control. It is equally important to apply the right amount of pesticide to control a specific pest. The amount of pesticide applied per unit area or per plant is known as the application rate.



A pesticide product label provides the application rate for a specific pest. The label is a legal document. Pesticide products can only be used to control pests listed on the label and can only be applied at specified rates. If higher application rates are used, there may be crop damage, harmful residues, excess runoff or damage to non-target plants or animals. If lower rates are used, the treatment may not be effective.

Preparations for pesticide treatment usually involve two procedures to ensure that application equipment will deliver the amount of pesticide specified on a product label. These procedures are:

- Adjust and calibrate the application equipment so that it will cover an area uniformly with the correct output.
- Calculate the amount of pesticide and carrier to add to the tank or hopper and calculate the amount of pesticide required for the entire treatment area.

Adjusting application equipment may require installation of nozzles or selection of operating pressures or ground speeds. After adjustment, equipment should be calibrated to measure its rate of delivery. Final adjustments may then be required

to correct the delivery rate. The first part of this section reviews general procedures for adjusting and calibrating four types of application equipment.

When equipment has been accurately adjusted to deliver the required output, relatively simple calculations are required to determine the amount of pesticide product to add to a spray tank or to apply to a specific treatment area. Several types of calculations may be required because application rates on pesticide labels are described in several ways. The second part of this section reviews the various ways that application rates are described and how to calculate pesticide requirements in each case.

EQUIPMENT ADJUSTMENT AND CALIBRATION

The first step in preparing for pesticide application is to select a pesticide and to determine the required delivery rate of the application equipment. When using granular pesticides, the delivery rate is the amount of granules discharged per unit area. The delivery rate must be adjusted to give the application rate specified on the product label (e.g. 45 kg/ha).

When pesticides are applied as a spray, the equipment delivery rate is the spray volume applied per unit area. The operator must select the spray volume that is appropriate for the proposed treatment. Some label directions indicate a specific spray volume, e.g. "apply 5 L pesticide in 600 L of water per hectare". Other label directions do not indicate a specific spray volume, e.g. "apply 5 L pesticide in up to 500 L of water per hectare" or "in 200 to 600 L of water per hectare". When the spray volume is not specified, the operator must consider such factors as the following:

- the coverage required (spraying to runoff requires a greater spray volume than spraying only to wet surfaces)
- the surface to be treated (dense foliage or porous surfaces may require a greater spray volume)
- droplet sizes (a high spray volume generally means coarse sprays can be used)
- mixing requirements (a high spray volume may require large spray tanks or frequent stopping to mix spray solutions).

If spray volumes are not specified, herbicides are generally sprayed in 300 to 600 L of carrier/ha. Insecticides and fungicides are generally sprayed in 1,000 L of carrier/ha. Aerial applications may use lower spray volumes, e.g. 25 to 200 L/ha are commonly used.

The three main factors which determine delivery rate are: output, ground speed and swath width.

Equipment Output

Equipment output is the amount of pesticide discharged per unit time (e.g. kg/min or L/min). For granular spreaders, operator instructions generally indicate what output setting to use and what speed to drive in order to deliver a specific swath width and application rate. In liquid spray equipment, the output is dependent on the number of nozzles, the nozzle opening sizes and line pressure. The nozzle manufacturers typically provide charts which show the combination of nozzle type and pressure which will produce a desired output (L/min). However, these output values should be checked in the field during equipment calibration. Most charts of output are based on the flow characteristics of water.

Ground Speed

Ground speed of the equipment is inversely related to its output. If the speed that the application equipment travels over the ground is doubled, the delivery rate (kg/ha or L/ha) is halved. Motorized equipment speeds are typically between 3 and 12 km/h. If the speed is too fast, drift is increased, if speed is too slow, application time may be too long. Motorized equipment must be operated at a speed suited to the equipment. Tractor or truck speedometers are often inaccurate in the field due to wheel slippage. It may be necessary to check the forward speed under field conditions by recording the time taken to drive a measured distance. The gear and throttle setting or rpm should be recorded for use during pesticide application.

Swath Width

Swath width is the width over which spray droplets or granules are distributed as the equipment moves along its path. In broadcast applications, the pesticide is applied uniformly over the treatment area in overlapping passes. Swath width is measured from the centre of overlap between each pass. In band applications, the pesticide is applied to a strip such as a crop row. The swath width is the width of the band(s) applied in one pass.

Nearly all pesticide application equipment (except ready-to-use aerosol cans or hand dusters) requires calibration. Calibration is the measurement of equipment delivery rate in a test which approximates typical operating conditions. Calibration should be done when new equipment is to be used, when the pesticide product or dilution is changed and at regular intervals to determine whether wear has changed pesticide output. Sprayers with brass nozzles should be recalibrated after about 25 hours of use. Sprayers with stainless steel nozzles should be recalibrated after about 50 hours of use. Calibration should be done more frequently when abrasive wettable powders are used.

Details on equipment adjustment and calibration are described for four types of applicators in the following sections.

HAND HELD / BACKPACK SPRAYERS

Often a grower needs to treat a small area of his crop with a pesticide; a so-called spot treatment. A small garden or compressed air sprayer can be used effectively. Calibration of these portable sprayers is required to check the spray pattern and spray volume per unit area.

Calibration Procedure

1. Fill the spray tank to a mark with water. Pump to the pressure which will be used during the pesticide application.

2. Apply the spray of water to 100 m^2. Walk at a steady pace, taking care to apply as evenly as possible.

3. Measure the amount of water needed to refill the spray tank to the mark. This volume will be the sprayer's output per 100 m^2.

If the spray tank is not large enough to cover an area of 100 m^2, use the following calibration procedure.

1. Measure the amount of water required to fill the sprayer. Pump to the pressure which will be used during the pesticide application.

2. Spray an area as evenly as possible, walking at a steady pace. Spray until the tank is empty. Measure the number of square metres covered.

3. Use the recommended amount of pesticide for this number of square metres with each filling of the tank.

As a guide to converting the recommended rate of any pesticide to the amount required for a small area, 32 grams per 100 square metres is equal to 3.2 kg per hectare. For liquid measure, 1 litre per 100 square metres is equal to 100 litres per hectare. One level tablespoon is approximately 15 mL.

MOTORIZED PRESSURE SPRAYERS

Most motorized pressure sprayers, including boom sprayers for broadcast or band treatments and boomless broadcast sprayers, require similar adjustment decisions and calibration steps. The three main variables which determine spray volume applied are nozzle output, ground speed and swath width.

Nozzle output depends on the size of the nozzle opening and pump pressure. Nozzle manufacturers help applicators choose the right tip for each type of treatment by providing detailed charts of tip performance. Such charts often show the nozzle tip that will produce a specified spray volume (L/ha) for a given ground speed (km/h), pressure (kPa), output (L/min) and nozzle spacing as shown in Table 12-1. Nozzles should be selected which match as closely as possible the spray volume, ground speed, pressure and nozzle spacing required.

Some charts of nozzle specification only list their output rates for a given pressure. In such a case it is necessary to calculate the output (L/min) which will give the desired spray volume (L/ha). Use the formula:

$$\text{Output (L/min)} = \frac{\text{spray volume (L/ha)} \times \text{speed (km/h)} \times \text{swath width (m)}}{600^{1}}$$

For example: What should the output (L/min) of a nozzle be in order to apply 110 L/ha with a swath width of 50 cm and a ground speed of 10 km/h?

Answer:

$$= \frac{110 \text{ L/ha} \times 10 \text{ km/h} \times 0.5 \text{ m}}{600}$$

$$= 0.92 \text{ L/min}$$

Nozzle tips should be installed on a boom using the spacing and boom height specified by the manufacturer. Nozzle tips should be aligned carefully as misalignment is a common cause of uneven coverage. The boom must also be level. If not, the spray pattern will be uneven.

When using overlapping nozzles on a boom, manufacturers typically recommend a 30% overlap[2] of spray from adjacent nozzles. The height of the boom alters the percent overlap. The boom height should be set at the height recommended by the nozzle manufacturer, then adjusted during calibration if necessary (Figure 12-1). Note that selecting nozzles with a wide spray angle permits a lower boom height, thus reducing the amount of spray drift. Increasing the line pressure increases the spray angle of some nozzles which then requires readjustment of boom height. The boom height may also have to be adjusted periodically if spraying a crop with a variable height.

[1]A constant to convert km/h to m/min and to convert L/m² to L/ha:

$$\frac{60 \text{ min}}{1 \text{ hr}} \times \frac{1 \text{ km}}{1{,}000 \text{ m}} \times \frac{10{,}000 \text{ m}^2}{1 \text{ ha}} = 600$$

[2]Recently there has been a trend to use wide angle nozzles (110°) and 100% overlap of spray patterns. This 100% overlap reduces the variability of the spray deposit if there are small changes in boom height during application.

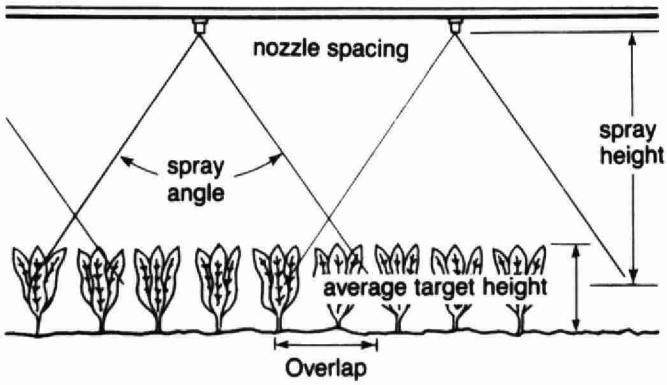


Table 12-1. Chart of spray volumes for various fan nozzle types, pressures and ground speeds.

Delavan Nozzles	Teejet Nozzles		Pressures	Output	Spray Volume (L/ha) at			
65 & 80°	65°	80°	(k/Pa)	(L/min)	6 km/h	8 km/h	10 km/h	12 km/h
LF-0.67	650067 &	800067	200	0.22	43	32	26	22
			275	0.25	51	38	31	25
LF-1	6501 &	8001	200	0.32	64	48	39	32
			275	0.38	76	57	45	38
LF-1.5	65015 &	80015	200	0.48	97	73	58	48
			275	0.57	113	85	68	57
LF-2	6502 &	8002	200	0.64	129	97	77	64
			275	0.76	151	113	91	76
LF-3	6503 &	8003	200	0.97	193	145	116	97
			275	1.13	227	170	136	113
LF-4	6504 &	8004	200	1.29	258	193	155	129
			275	1.51	302	227	181	151

Note: Nozzles spaced at 50 cm

Swath width of a boom sprayer with overlapping spray patterns is the width between nozzles (or drop pipes) times the number of nozzles. Note that the swath width will be wider than the distance between outermost nozzles (Figure 12-2).

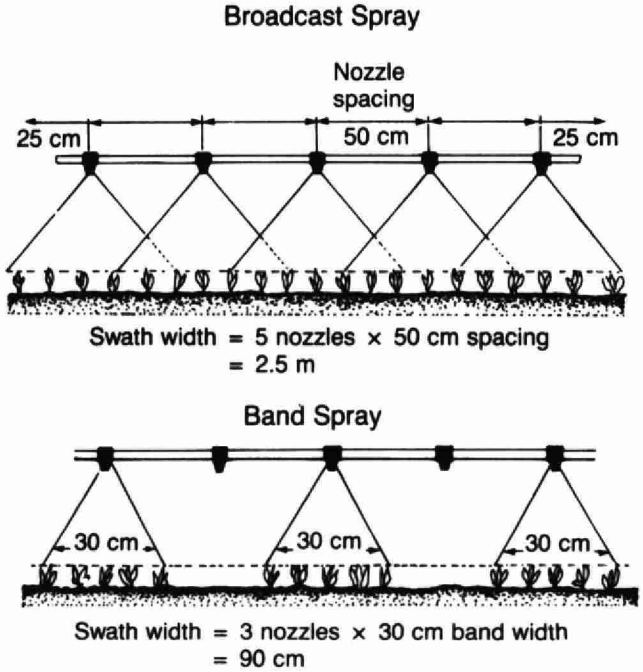


Figure 12-2

On a boom sprayer used for band applications the boom height influences the width of the band the nozzle sprays. The boom height must be adjusted to achieve the desired band width for the angle of nozzle selected. Swath width of a band sprayer is the sum of the widths of the nozzle spray patterns (Figure 12-2).

On a boomless sprayer, nozzle selection charts often specify the swath width produced by nozzles at a given height. An overlap percentage may also be recommended for adjacent swaths. The effective swath width includes half the width of overlap of adjacent swaths.

When the sprayer is set up, it should be calibrated to ensure that it is functioning properly under treatment conditions. There are many ways of determining the number of litres of spray material that is being applied to one hectare of land - or calibrating a sprayer. Here are two methods that are straight-forward and the resulting calculations are relatively simple.

Calibration Procedure (from OMAF Pub. 75 - Guide to Weed Control)

Method 1.

1. Set out two stakes 200 m (656 ft) apart in the field. Do not use a different distance. To do so will give the wrong value to use in the calculation because the factor used in the equation with this method is obtained by dividing the number of square metres in one hectare by the distance travelled as follows:

$$\frac{10{,}000\ m^2}{200m} = 50^3$$

2. Add sufficient clean water to the sprayer to conduct the following precalibration adjustments:

   Adjust the boom height to give the amount of overlap recommended by the sprayer manufacturer for the nozzle tips and nozzle spacing used. For example, for a spray angle of 65 degrees the boom should be 53 to 58 cm above the surface to be sprayed, for 80 degrees the height should be 42 to 48 cm.

   Operate the sprayer and adjust the by-pass relief valve to give the desired pressure while the nozzles are operating. This will also ensure that the sprayer lines are full of water.

3. Fill the tank and record the water level on the sight gauge on the tank or with a measuring stick.

4. Spray between the stakes in one direction at a definite speed and pressure. Turn the boom "on" as the first stake is passed and turn the boom "off" as the second stake is passed. Mark the throttle setting.

5. Return the sprayer to the same level location as before the calibration run. Carefully measure the amount of water required to refill the tank to the same mark on the sight gauge or measuring stick.

6. Calculate the application rate in litres per hectare using this formula:

$$L/ha = \frac{\text{litres water added x } 50}{\text{swath width in metres}}$$

   For overall spraying the swath width equals the number of nozzles x the nozzle spacing in metres.

[3] The factor is obtained by dividing the number of square metres in a hectare by the distance travelled.

Sample calculations:
Overall Spraying: If the sprayer has a 6.5 m swath width and 30 L of water are required to refill the tank, the application rate in litres per hectare is:

$$\frac{30 \times 50}{6.5} = 231 \text{ L/ha}$$

Band Spraying: If the sprayer has 10 nozzles and each nozzle covers a 36 cm (0.36 metres) band, the total width of the spray patterns (swath width) is:

$$10 \times 0.36 \text{ or } 3.6 \text{ metres}$$

If 10 litres of water are required to refill the tank, the application rate in litres per hectare is:

$$\frac{10 \times 50}{3.6} = 139 \text{ L/ha}$$

Method 2 (use of a calibration bottle)
A calibration bottle can be used to quickly determine the number of litres applied per hectare.

1. Ensure that all the nozzles are delivering the same rate. This can be done by operating all the nozzles at the pressure that will be used in the field. With a calibration bottle, collect the spray from each of the nozzles for a specific length of time. Clean/change nozzles to give an even rate across the boom length.

2. Operate the sprayer for the distance specified on the calibration bottle and note the time taken. This should be done by spraying between two stakes using the same constant forward speed as will be used in the field.

3. Operate the sprayer while stationary at the desired pressure and collect spray from any one of the nozzles for the time determined in step 2 above.

Read the rate of delivery directly off the bottle giving careful consideration to the nozzle spacing precautions and the units indicated on the bottle (gallons per acre or litres per hectare). If the calibration bottle has readings in gallons per acre this can be changed to litres per hectare by using the following conversions:

Imperial gallons per acre x 11 = litres per hectare (approx.)

U.S. gallons per acre x 9 = litres per hectare (approx.)

If calibration shows that equipment is not delivering the desired spray volume (L/ha), adjustments should be made and the sprayer retested. Adjustments to spray volume can be made in one of three ways:

- Changing pump pressure. Lower pressure means less spray delivered; higher pressure means more spray delivered. Only minor adjustments in pressure should be made because adjustment will change the spray droplet size.

- Changing nozzle tips. Changing nozzle output (L/min) is the preferred method for making a large adjustment to spray volume per hectare.

- Changing sprayer speed. Slower speed means more spray delivered per unit area; faster speed means less spray delivered. This is a practical method for most small adjustments to spray volume. Use the following formula:

$$\text{Required speed (km/h)} = \frac{\text{present speed (km/h)} \times \text{present spray volume (L/ha)}}{\text{desired spray volume (L/ha)}}$$

AIR-BLAST ORCHARD SPRAYERS

Air-blast sprayers use a high speed, fan-driven air-stream to disperse the spray through foliage. A series of nozzles inject the spray into the airstream which breaks up the droplets and blows them into the tree. Some sprayers direct spray to only one side at a time. Other sprayers direct the spray to both sides and require only one pass between tree rows.

Setting up air-blast sprayers for specific orchard conditions requires considerable knowledge. The most important output adjustments and calibration steps are reviewed in this section.

Air-blast sprayers may be used to apply a range of spray volumes per unit area, but the typical output is 560 to 840 L/ha. There are three main factors which govern spray volume.

Volume of Airstream

Large trees require a greater volume of air (e.g. 3.3 m^3/sec for trees up to 5.5 m high, 9 m apart) and dwarf trees require a smaller volume of air (e.g. 1.4 m^3/sec for trees up to 4 m high, 4.5 m apart). Use air volumes recommended in equipment manuals.

Ground Speed of Sprayer

Factors to consider when selecting speed of a sprayer are tree size and spacing, density of foliage, wind conditions and sprayer efficiency. The speed must be slow enough to allow the spray-laden airstream to establish itself up through the foliage. Larger trees with larger spacing between rows will require a slower speed. Use recommended speeds between 1.5 and 5.0 km/h. Too fast a speed will provide inadequate coverage in the top and centres of trees.

Nozzle Output

Nozzle output (L/min) is determined by pump pressure and nozzle opening size. For low-volume spraying, pump pressure is usually about 690 kPa. A lower pressure (about 105 kPa) is used with air-shear nozzles. The nozzle opening affects both output and breakup of the spray. If the nozzles are enlarged through wear, the output will increase and spray breakup will be deficient. Nozzles should be checked and replaced before serious wear occurs.

A set of spray nozzles must be selected with an output (L/min) which will deliver the correct spray volume (L/ha) at the desired ground speed. The required nozzle output can be calculated from the following formula:

$$\text{Output per side (L/min)} = \frac{\text{Spray volume (L/ha)} \times \text{space between rows (m)} \times \text{speed (km/h)}}{1{,}200^{4}}$$

[4]A constant to convert L/ha x m x km/h to L/m^2 x m x m/min = L/min. Multiply by one-half for output to one side = one-half the space between rows:

$$\frac{1\text{ L}}{10{,}000\text{ m}^2} \times \frac{1{,}000\text{ m}}{1\text{ km}} \times \frac{1\text{ hr}}{60\text{ min}} \times \frac{1}{2} = 1{,}200$$

For example: What should the output be for all nozzles on one side of an air-blast sprayer where the desired spray volume is 560 L/ha, the speed is 3.2 km/h, row spacing is 6 m and operating pressure 690 kPa?

Answer:

$$\text{Output of all nozzles on one side (L/min)} = \frac{560 \text{ L/ha} \times 6\text{m} \times 3.2 \text{ km}}{1{,}200}$$

$$= 8.96 \text{ L/min}$$

When the sprayer output (L/min) has been calculated, a set of nozzles can be selected from manufacturers' charts. The specified output of the individual nozzles must add up to the required output for the sprayer. Air-blast sprayers usually require six or seven nozzles arranged in an arc on manifolds on each side. The nozzles on the upper half of a manifold should emit about two thirds of the spray. Review the operating manual for more details on nozzle selection and arrangement.

After a set of nozzles has been selected, the spray volume applied by the sprayer should be calibrated using water. Calibration should also be repeated at the beginning of each season.

Calibration Procedure
(from OMAF Pub. 360 - Fruit Production Recommendations)

Proceed through the following seven steps:
1. Check the tractor speed:

Table 12-2 Time Required to Pass a Number of Trees at Different Driving Speeds

Tractor Speed km/h	IN THE ROW TREE SPACINGS (Metres) 6.1	7.6	9.1	10.0	10.7	12.2
	Time (Seconds) to Pass 10 Trees					
2.4	91	114	136	150	159	182
3.2	68	85	102	112	119	136
4.0	54	68	82	90	95	109
4.8	45	58	70	77	82	94
5.6	39	49	58	64	68	78
6.4	34	43	51	56	60	68

2. From the chart, find the number of minutes needed to spray a hectare at the speed recommended for your sprayer.

Table 12-3 Spraying Time Per Hectare (without turning and filling time)

Distance between rows (metres)	Tractor Speeds km/h 1.6	2.4	3.2	4.0	4.8	5.6	6.4
	Time in Minutes to Drive One Hectare						
3.0	125.0	82.5	62.5	50.0	41.25	35.0	31.0
4.6	82.5	55.0	41.25	33.0	27.5	23.5	20.5
6.1	62.5	41.25	31.0	25.0	20.5	17.75	15.5
7.6	50.0	33.0	25.0	20.0	16.5	14.0	12.5
9.1	41.25	27.5	20.5	16.5	13.75	11.75	10.25
10.7	35.25	23.5	17.75	14.0	11.75	10.0	8.75
12.2	31.0	20.5	15.5	12.5	10.25	9.5	7.75

3. Decide how many litres of liquid per hectare you wish to use (considering time available, size of sprayer, size of trees and time of day spraying will be done.)

4. Find the sprayer output required thus:

$$\frac{\text{litres per hectare}}{\text{time per hectare}} = \text{litres per minute (for all nozzles)}$$

5. Divide this output by the number of nozzles:

$$\frac{\text{litres per minute}}{\text{number of nozzles}} = \text{litres per minute per nozzle}$$

6. From manufacturer's chart[5] find a nozzle to give this output. Then choose nozzles with smaller outputs for top and bottom positions and larger ones for the upper third of each side. When added, the total output should be close to the value shown in No. 4 (L per min). For small trees, block off one or two of the top nozzles and shut off between trees to prevent waste of spray.

7. Determine the actual sprayer output (L/min). Measure the amount of water discharged from the tank for a specific period of sprayer operation. Fill the spray tank with some water and mark the level on a measuring stick. Spray out the water for 10 minutes at the desired pump pressure. Measure the water left in the tank or the amount required to refill the tank to the original level and calculate how much was sprayed out. Divide the amount sprayed out by 10 to give the flow rate in litres per minute (value to be similar to step 4).

Adjust spray volume applied if necessary. If the spray volume is not suitable, adjust the pressure slightly or change one or more nozzles and repeat the 10 minute output check.

GRANULAR APPLICATION EQUIPMENT

Granular application equipment includes broadcast spreaders, band spreaders and soil injectors. Granules may be distributed by gravity feed, whirling discs (spinners) or air-blast methods. The delivery per unit area (kg/ha) depends on the ground speed of the equipment, the swath width and the output (kg/min) of granules. Equipment output depends on the size of the adjustable hopper openings, the size, weight and shape of the granules and the roughness of the terrain. Equipment should be calibrated for each batch of product used and for new field conditions.

Equipment should be adjusted initially by following the manufacturer's instructions in the equipment manual. Use recommended output settings for the type of granules and use the recommended speed, taking into consideration the application site. Soft, muddy or uneven surfaces require lower speeds.

Calibration Procedure

1. Check the swath width and application pattern. Fill the hopper with some granules. Drive a short distance at the desired speed. Measure the width of the swath and check for uniform distribution along the swath width. If granule pattern is uneven, adjustments may be required to the speed of the spinner or the spot on the spinner where the granules land.

[5] Pages 40-47, Publication 373, Orchard Sprayers.

2. If the spreader can be operated while the tractor is stationary, use this method to measure delivery rate (kg/ha), otherwise use method 3 below.

   (a)Fill the hopper about half-full of granules

   (b)Determine the exact ground speed during application. Calibrate the speed by driving a measured distance, e.g. 200 m, with the spreader shut off. Record the throttle setting and gear used. Note the time it takes in seconds. Calculate actual speed by using the following formula:

$$\text{Speed (km/h)} = \frac{\text{distance travelled (m)} \times 3.6}{\text{time (sec)}}$$

   (c)Run the spreader while the unit is stationary and collect the granules discharged from one tube or opening for a timed interval, e.g. 2 min. Weigh the granules and calculate the output per minute.

   (d)Calculate the delivery per unit area using the following formula:

$$\text{Delivery rate (kg/ha)} = \frac{\text{output (kg/min)} \times 600}{\text{speed (km/h)} \times \text{swath width (m)}}$$

3. Another method to determine delivery per unit area is to measure the output while driving a measured distance.

   (a)Fill the hopper half-full of granules.

   (b)Mark out a distance of 200 m or more.

   (c)Collect the material discharged from the spreader in a bag or box while driving the tractor over the 200 m distance.

   (d)Weigh the granules discharged into the container and calculate the output per hectare by the following formula:

$$\text{Delivery rate (kg/ha)} = \frac{\text{amount applied to test area (kg)} \times 10{,}000\ \text{m}^2/\text{ha}}{\text{distance travelled (m)} \times \text{swath width (m)}}$$

4. Adjust the applicator delivery rate if calibration shows the equipment is not delivering within 5% of the required application rate, adjust the ground speed during application or adjust the granule output setting on the spreader and recalibrate. If the required output of granules was 45 kg/ha, then 5% = 0.05 x 45 = 2.25 kg/ha. The lowest acceptable delivery rate would be 45 – 2.25 = 42.75 kg/ha. The highest acceptable rate would be 45 + 2.25 = 47.25 kg/ha.

   In order to calculate the speed required to obtain the desired delivery rate, use the following formula:

$$\text{Required speed (km/h)} = \frac{\text{present speed (km/h)} \times \text{present delivery rate (kg/ha)}}{\text{desired delivery rate (kg/ha)}}$$

PESTICIDE USE CALCULATIONS

Pesticide use calculations are required to answer the following kinds of questions:

- How much pesticide should be added to a spray tank?
- How large an area will one tank of spray or one hopper of granules cover?
- How many tankfuls or hopperfuls are required for the treatment?
- How much pesticide is required for the treatment?
- How would a spray mix be changed to a different percent concentration of pesticide?

Generally, pesticide use calculations are based on the calibrated delivery rate of the application equipment. If exactly how much a sprayer is delivering per hectare is known, it is possible to calculate exactly how much pesticide is required.

The mathematics used to answer these questions are simple. However, there is some variation in the calculations required for different types of pesticides. In the following examples, calculations are shown for pesticides with different types of application rates.

The first step in all the examples below is to convert measurements to metric units. This includes the size of the treatment area and the capacity of the spray tank or hopper. Use the following formulae:

Areas
Field size (acres) x 0.405 = Field size (ha)
Field size (yd^2) x 0.836 = Field size (m^2)

Capacity
Tank size (imperial gallons) x 4.55 = Tank size (L)
Tank size (U.S. gallons) x 3.97 = Tank size (L)

GRANULAR PESTICIDES

The application rate for granular pesticides is usually expressed as an amount of product to apply to a specific area. No mixing is required, so these calculations are very easy.

For example: A label specifies 75 kg of granular product per hectare. The treatment area is 2.1 ha. The spreader is adjusted and calibrated so that it delivers a rate of 77 kg/ha which is within 5% of the required application rate. The hopper holds 30 kg. The application is to be a broadcast treatment, i.e. the entire field is to be treated.

Step 1. Determine how large an area one hopperful will treat.
If treating a large area, it is a good idea to determine the area which can be treated by one hopperful. Then, check that this area was in fact covered after applying the hopperful.

Divide the hopper capacity by the calibrated delivery rate.

30 kg ÷ 77 kg = 0.39 ha covered by one hopperful
= 3900 m^2 (1 ha = 10,000 m^2)

Step 2. Determine how much pesticide is required for the total treatment.
Multiply the field size times the calibrated delivery rate.

2.1 ha x 77 kg/ha = 161.7 kg pesticide required.

Step 3. Determine how many hopperfuls are required.
Divide the total pesticide required by the capacity of the hopper.

161.7 kg ÷ 30 kg = 5.4 hopperfuls required.

Note that if the spreader delivery rate was calibrated for 770 g per 100 m^2 this rate must first be converted to delivery per 1 m^2 or 1 ha in order to use the formula in steps 1 and 2 above. Thus to find the area treated by one hopper in step 1, first convert g/100 m^2 to g/m^2, e.g.

$$\text{Delivery rate} = \frac{770 \text{ g}}{100 \text{ m}^2} = 7.7 \text{ g/m}^2$$

Then, divide the hopper capacity (30 kg = 30,000 g) by the calibrated delivery rate, e.g.

30,000 g ÷ 7.7 g/m^2 = 3,896 m^2
= 0.39 ha covered by one hopper.

For a **band treatment,** where only crop rows or spaces between crop rows are treated, an additional step may be required. If the calibrated delivery rate is for the treated bands only, the delivery rate per total area of field must be calculated.

For example: the calibrated delivery rate per band is 77 kg/ha, the crop rows are spaced at 50 cm and the band width is 15 cm (Figure 12-3).

Step 1a. Convert pesticide applied per band to pesticide applied per total area.

Multiply band delivery rate times the width of a band divided by the distance between rows.

$$77 \text{ kg/ha} \times \frac{15 \text{ cm}}{50 \text{ cm}} = 23.1 \text{ kg/ha}$$

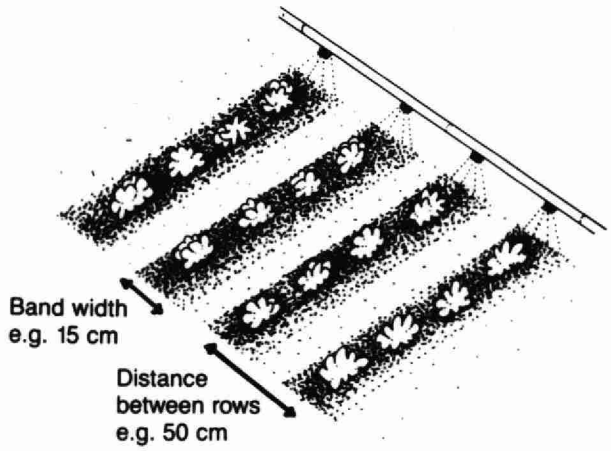


Figure 12-3 Relation between band widths and distance between crop rows.

In this example, the application rate on the label would be 75 kg/ha. The calibrated delivery rate in the treated bands is 77 kg/ha. The delivery rate when averaged over the whole field would be 23.1 kg/ha. Use the delivery rate per total area when calculating pesticide use in Steps 1 to 3 above.

For some band treatments, the application rate is given as the amount of pesticide to apply per length of crop row (e.g. apply 40g/100 m row). Calculate pesticide requirements per length of row as in Steps 1 to 3 above.

For example: Calculate how much pesticide is required to treat 20,000 linear metres of crop row if the application rate is 40g/100 m row.

Multiply the application rate times the length of crop row.

Application rate = 40g/100 m = 0.4 g/m
0.4 g/m x 20,000 m = 8,000 g = 8 kg pesticide required.

PESTICIDE APPLIED IN SPRAY MIXTURES

Application rates for pesticides applied in spray mixtures are either given as the pesticide concentration in the spray mixture or the amount of pesticide to apply per unit area. When the amount of pesticide per unit area is specified, the rate of dilution may be specified or may be left to the discretion of the operator. When the application rate is expressed as a concentration, instructions may be given to mix a certain amount of pesticide per volume of spray, or to make a spray solution with a specified percent active ingredient. Calculations to determine pesticide requirements are shown below (A-D) for each of these types of application rate.

A. THE PESTICIDE IS TO BE MIXED IN A SPECIFIED VOLUME OF SPRAY

Label directions may indicate the amount of pesticide to mix in a carrier such as water or oil, with instructions to cover the area being treated. This type of direction is given for many pesticides used for spraying ornamentals or for spot treatments using herbicides.

For example: The application rate on the label specifies that 7 L of liquid concentrate should be added per 100 L of water[6]. The spray tank holds 10 L. The calibrated sprayer has a delivery rate of 4 L per 100 m^2. A broadcast treatment over 300 m^2 is required.

Step 1. Calculate how much spray is required in total.
Multiply the sprayer delivery rate times the total treatment area.

Delivery rate – 4L/100 m^2 = 0.04 L/m^2
0.04 L/m^2 x 300 m^2 = 12 L spray required

Step 2. Calculate how many spray tankfuls are required.
Divide the total required spray by the tank capacity.

12 L spray ÷ 10 L tank capacity = 1.2 tanks required.

Step 3. Calculate how much pesticide to add to the spray tank. (The first tankful will hold 10 L of spray, the second will be a partial tankful of 2L).

Multiply the dilution rate by the tank spray volume.

0.07 L/L x 10 L = 0.7 (700 ml) pesticide should be added.

Step 4. Calculate how much pesticide is required in total.
Multiply the dilution rate times the total spray required.

0.07 L pesticide/L spray x 12 L spray = 0.84 L (840 ml) pesticide required.

[6]Note that an application rate of 7 L per, or in 100 L of water means 7 L of product with 93 L of water to make 100 L of spray mix. It would be different if the label read "add 7 L of pesticide with or to 100 L of water". Then, the total spray mix would make 107 L.

Note that if the application rate was given as 70 g wettable powder per 100 L, one would follow the same steps. Thus to calculate how much pesticide powder to add to a 10 L spray tank, multiply the dilution rate times the spray volume.

Dilution rate = 70 g/100 L = 0.7 g/L
0.7 g/L x 10 L spray = 7 g pesticide required.

Note that if the calibrated sprayer output was an amount of spray per individual tree (e.g. 2L/tree) one would perform the same calculations in Steps 1 through 4. Thus, to calculate how much spray is needed, for 50 trees, multiply the sprayer output per tree times the total number of trees.

2 L spray/tree x 50 trees = 100 L spray required in total.

B. THE PESTICIDE IS TO BE MIXED IN A VARIABLE VOLUME OF SPRAY AND APPLIED AT A SPECIFIED RATE PER AREA

This rate is often specified for herbicides. The amount of carrier mixed with the herbicide is not as critical as the amount of pesticide applied per unit area.

For example: The label requires application of 1.8 L of liquid concentrate in 200 to 600 L of water per ha. The calibrated sprayer delivers 412 L of spray per ha which is sufficient for the treatment. The spray tank holds 500 L of spray. The total treatment area is 5 ha.

Step 1. Calculate how much spray is required in total.
Multiply the sprayer delivery rate (L/ha) times the total treatment area.

412 L/ha x 5 ha = 2,060 L spray required.

Step 2. Calculate how large an area one tank will cover (use the same procedure for a full tank of 500 L or a partial tank).
Divide the volume of spray in the tank (L) by the sprayer delivery rate.

500 L ÷ 412 L/ha = 1.214 ha will be covered

Step 3. Calculate how much pesticide to add to a spray tank.
Multiply the application rate (L/ha) times the number of hectares covered by the spray tank.

1.8 L/ha x 1.214 ha = 2.18 L pesticide should be used.

Step 4. Calculate how much pesticide is required in total.
Multiply the application rate times the number of hectares to be treated.

1.8 L/ha x 5 ha = 9 L pesticide required

Step 5. Calculate how many tankfuls are required.
Divide the total spray required by the tank capacity.

2,060 L ÷ 500 L/tankful = 4.12 tankfuls required

Step 6. Calculate how much pesticide to add to the partial tank of 0.12 x 500 = 60 L.
Use the formulae in Steps 2 and 3.

For a band treatment, where only crop rows or spaces between crop rows are treated, additional calculations are required. The pesticide application rate and the spray volume per hectare are for the treated bands only. The application rate and spray volume per hectare for the treatment area must be calculated.

For example: The application rate is 1.8 L/ha of pesticide product, the calibrated spray volume is 412 L/ha. The crop rows are spaced at 50 cm intervals and the band width is 15 cm (see Figure 12-3).

Step 1a. Convert the pesticide applied per band area to pesticide applied per total area.
Multiply application rate times the width of a band divided by the distance between rows.

$$1.8 \text{ L/ha} \times \frac{15 \text{ cm}}{50 \text{ cm}} = 0.54 \text{ L/ha}$$

Step 1b. Convert the spray volume per hectare for the band area to spray volume per hectare for the total treatment area.
Multiply calibrated spray volume per band area times the width of a band divided by the distance between rows.

$$412 \text{ L/ha} \times \frac{15 \text{ cm}}{50 \text{ cm}} = 123.6 \text{ L/ha}$$

In this example of a band treatment, the application rate would be 0.54 L/ha averaged over the whole field. The spray volume would be 123.5 L/ha averaged over the whole field. Use these values when calculating pesticide use requirements in Steps 1 to 6 above, for a band treatment.

Note that the application rate may specify an amount of pesticide to mix in a variable amount of spray per length of crop row (e.g. apply 375 g of wettable powder in 150 to 750 L of water per 1,000 m of crop row). The same steps should be followed as in the example above. You must know the calibrated spray volume (e.g. 400 L of water per 1,000 m crop row), the length of row to be sprayed and size of the spray tank.

C. THE PESTICIDE IS TO BE MIXED IN A SPECIFIED VOLUME OF SPRAY TO APPLY TO A SPECIFIED AREA

This type of application rate may be required for some herbicides, insecticides or fungicides where both the concentration of the pesticide in the spray and the amount of spray applied per unit area are critical. The calculation steps are the same as in Section B where the application rate does not specify spray volume. Calculations must be based on calibrated spray volumes per unit area in both cases.

For example: A label specifies 2.5 kg of wettable powder in 150 L of water per 1,000 m^2. The sprayer is calibrated for a delivery rate of 144 L/1,000 m^2, which is within 5% of the required output. The spray tank holds 800 L and the treatment area is 4 ha.

Step 1. Calculate how much spray is required in total.
Multiply the spray volume (L/ha) times the total treatment area (ha).

$$\text{Spray volume (L/ha)} = \frac{144 \text{ L}}{1000 \text{ m}^2} \times 10{,}000 \text{ m}^2/\text{ha}$$

$$= 1{,}440 \text{ L/ha}$$

$$1{,}440 \text{ L/ha} \times 4 \text{ ha} = 5{,}760 \text{ L spray required}$$

Step 2. Calculate how large an area one tank will cover (use the same procedure for a full tank or a partial tank).
Divide the volume of spray in the tank by the spray volume (L/ha).

800 L ÷ 1,440 L/ha = 0.55 ha will be covered

Step 3. Calculate how much pesticide to add to a spray tank.
Multiply the application rate (kg/ha) times the number of hectares covered by the spray tank.

$$\text{Application rate} = \frac{2.5 \text{ kg}}{1{,}000 \text{ m}^2} \times 10{,}000 \text{ m}^2/\text{ha}$$

$$= 25 \text{ kg/ha}$$

25 kg/ha x 0.55 ha = 13.75 kg pesticide required

Step 4. Calculate how much pesticide is required in total.
Multiply the application rate (kg/ha) times the number of hectares to be treated.

25 kg/ha x 4 ha = 100 kg pesticide required

Step 5. Calculate how many spray tankfuls will be required.
Divide the total required spray by the tank capacity.

5,750 L ÷ 800 L/tankful = 7.2 tankfuls required.

Step 6. Calculate how much pesticide to add to the partial tank of 0.2 x 800 L = 160 L.
Use the formulae in Steps 2 and 3.

D. CHANGING THE CONCENTRATION OF A SPRAY MIXTURE.

On rare occasions it may be necessary to change the concentration of spray solution, either to use up left-over spray on a treatment requiring different dilutions, or because a mistake was made in the initial mixing operation. Two examples are given below to indicate the calculations involved.

For example: There is 50 L of a 2% spray solution in a tank. How much pesticide product should be added to the tank to make 100 L of a 5% solution, the pesticide product contains 40% active ingredient.

Step 1. Determine the amount of active ingredient in the 50 L of 2% spray, the active ingredient required in 100 L of 5% spray and then how much product added to the 50 L of 2% spray.

There is 2% x 50 L = 1 L a.i. in the tank
Require 5% x 100 L = 5 L a.i. in the tank
Therefore, add 5 L − 1 L = 4 L a.i.

Step 2. Determine how much 40% a.i. pesticide product must be added to increase the active ingredient by 4 L.
Divide the volume of active ingredient by 40%

$$4 \text{ L} \div 40\% = 4 \text{ L} \div \frac{40}{100} = 10 \text{ L pesticide product required to make 100 L of 5\% spray}$$

For example: There is 50 L of 5% spray in a tank. How much water should be added to the 50 L to make a 2% spray.

Step 1. Determine the amount of active ingredient in 50 L of 5% spray.
There is 5% x 50 L = 2.5 L a.i. in the tank

Step 2. Determine how much 2% spray can be made with 2.5 L a.i.
Divide 2.5 L by 2%

$$2.5 \div 2\% = 2.5 \div \frac{2}{100} = 125 \text{ L}$$

Step 3. Determine how much water to add to 50 L to make 125 L.
125 L − 50 L = 75 L must be added to obtain a 2% solution.

DISPOSAL

The problem of disposal must be faced each time a pesticide is purchased. After filling the spray tank there are empty containers to deal with. Often pesticides are left in the tank after application. The storage of pesticides may result in surplus chemicals due to damaged containers or old inventory. Never be careless when disposing of empty containers, extra tank-mix or surplus pesticide concentrates. Take the time to prevent pesticide misuse and environmental damage by following proper disposal procedures.

EMPTY PESTICIDE CONTAINERS

After each pesticide application the grower will be left with a number of empty pesticide containers. Actually these pesticide containers are not "empty". On average, an empty container will still hold approximately 1% of its original pesticide content. Though this figure appears to be low it poses a hazard to man and his environment. Never allow children to play with empty containers or give them to homeowners for any use.

Rinse Containers
To reduce the hazard of "empty" pesticide containers rinse **each** container as the spray tank is filled. Use either the manual triple rinse technique or a specially designed rinsing device to rinse containers.

To Triple Rinse

fill the empty container **at least** 10% full of diluent (usually water).

↓

cap, then shake or roll the container so that the inside surfaces of the container are well rinsed.

↓

empty rinsings into the spray tank

↓

repeat procedure twice

Remember to check the containers after rinsing is complete. Make sure that no pesticide has been left behind as a cake or paste on the bottom of the container.

Rinsing Devices
Rinsing devices are available. These devices, with the use of pressurized water, are just as effective as triple rinsing but are less time consuming. Follow manufacturers instructions.

The Pesticides Act regulates how pesticide containers are to be disposed of in Ontario.

A container that has been used to hold a Schedule 1, 2 or 5 pesticide shall be disposed of,

a) by puncturing or breaking and burying the container in such a manner that it is covered by at least 50 centimetres of soil and is not near any watercourse or water table; or

b) where the container is constructed of paper or cardboard, by burning, in circumstances that persons and animals are kept out of any resultant smoke and any resultant smoke is directed away from buildings, highways, roads or outdoor areas frequented by the public (Pesticides Act, 1980, Reg. 751, s.25)

For Metal, Plastic or Glass Containers

Once containers are properly rinsed they should be punctured (metal and plastic) or crushed (glass) to make them useless for any future use. It is often more convenient to store empty, rinsed containers until a sufficient amount for disposal have been collected. If this is the case, keep the containers in a secure area until they can be properly disposed of. The containers should be buried under at least 50 cm. of soil. Be certain that the burial site chosen is not near any watercourse or in a high water table area. It is also possible to take the rinsed containers to the local landfill site.

For Paper or Cardboard Containers

Paper or cardboard containers are often rigid enough to withstand rinsing. If it is possible, triple rinse these containers as you fill the tank. The containers can then be burned in an isolated area. The fire's smoke may contain toxic fumes from burning pesticide. Be certain that there is no chance that a person or animal breathes in this smoke. Make sure that the smoke does not drift towards any buildings, roads, or any public outdoor areas. These containers can also be buried or taken to local landfill site similiar to that of metal, plastic or glass containers. If disposal is delayed, gather the containers into a secure area such as the pesticide storage area.

A summary of how to properly dispose of empty pesticide containers is found below.

Rinsing and Disposal of Containers

Pesticide Container	Formulation	Rinsing Technique	Method of Disposal
Plastic	SN,EC,Fl,Li,Su	Jet or triple rinse	Puncture and bury
Metal	SN,EC,Fl,Li,Su	Jet or triple rinse	Puncture and bury
Paper bag	GR,WP,SP	Shake empty	Burn or bury
Plastic bag	GR,WP,SP	Single rinse	Burn or bury
Glass bottle	SN,EC	Triple rinse	Break and bury
Drum (200L)	SN,EC,Fl,Li,Su	Triple rinse	Recycle

EC-emulsifiable concentrate, Fl-flowable, GR-granular, Li-liquid, SN-solution, SP-soluble powder, Su-suspension, WP-wettable powder

SURPLUS TANK MIX

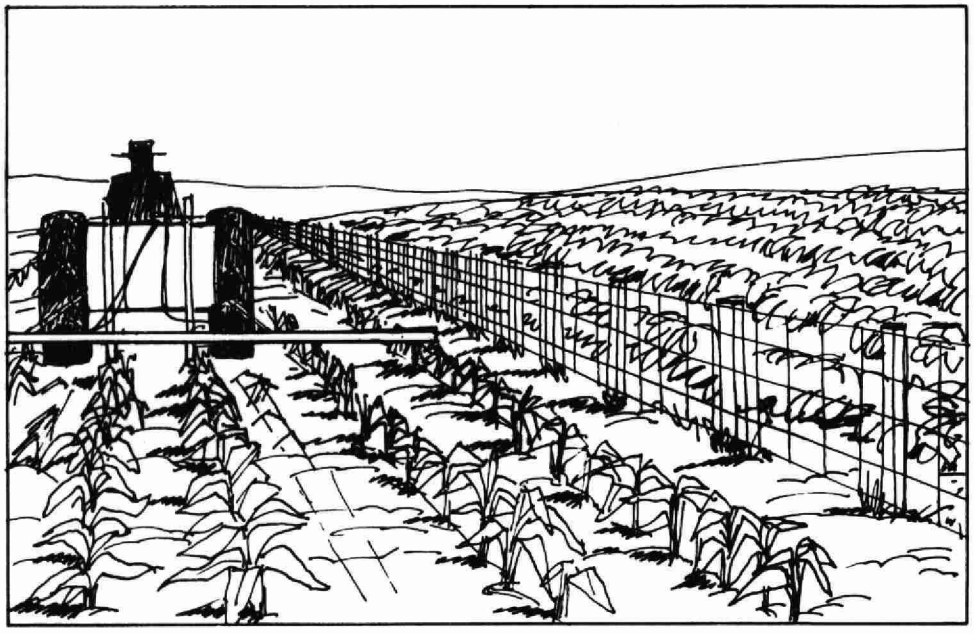
Once the spray operation is finished, the tank may not be completely empty. Try to avoid this situation. Not only is excess tank-mix a disposal problem but also a waste of good pesticide.

Avoid Surplus Tank Mix

Check the quantity required before beginning to mix up the pesticide solution. Make sure the pest problem has been properly identified and the right pesticide has been chosen. This will prevent having to get rid of a tank-load of the wrong pesticide. Estimate the size of the area that needs the pesticide application. The amount of spray solution required can be determined by knowing the size of the area to be sprayed and the output of the sprayer.

Disposal of Surplus Tank Mix

NEVER re-spray the treated field with the excess tank mix. Spraying an area twice will double the recommended rate of pesticide application. This may lead to problems with harmful pesticide residues in the harvested crop or in the soil and possible crop damage. The wisest disposal of any excess tank mix is to find other fields that require an application of this pesticide. Before spraying make sure the pesticide is registered for use on that crop. If no such area can be found dilute the remaining spray solution 10 to 1 with water. This diluted solution can be applied to the treated area causing no appreciable increase in pesticide rate.



SURPLUS PESTICIDE IN STORAGE

Check the storage area for surplus pesticides. The less pesticide stored, the less chance of a pesticide accident occurring.

Avoid Surplus Pesticides

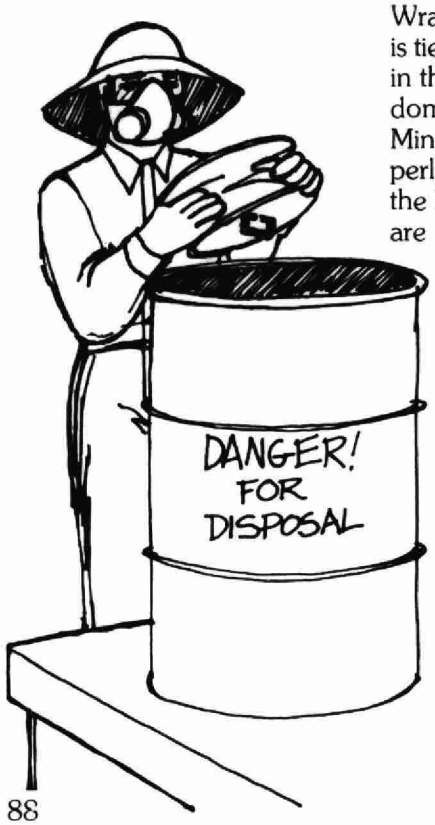
Make an effort to reduce pesticide surpluses by buying wisely. Keep an accurate inventory of all pesticides in storage. Remember to use old inventory before purchasing more pesticides. It is a good idea to mark the purchase date on each pesticide container. The majority of pesticides will retain their effectiveness for two or more years if stored properly - meaning cool (not freezing) and dry storage conditions. If uncertain of the activity of older pesticide supplies use the following guidelines to **help** determine their effectiveness.

Formulation	Discard material if:
Dust	excessive lumping is evident
Emulsifiable and spray concentrate	the solution does not turn milky when mixed with water or if the mixture separates or if a sludge forms;
Flowables	a layer of caked material on container bottom (may or may not go back into suspension with agitation)
Granulars	excessive lumping or caking is evident, and it does not run freely;
Solutions	active ingredient crystallized out and settled on bottom (may get back into solution with agitation - refer to product's label)
Wettable powders	material is lumpy and powder will not mix with water

When buying pesticides, estimate the amount needed and purchase only what is needed for one season. Make sure that the right pesticide is bought. Read the label. Be sure that the pesticide will control the pest problem.

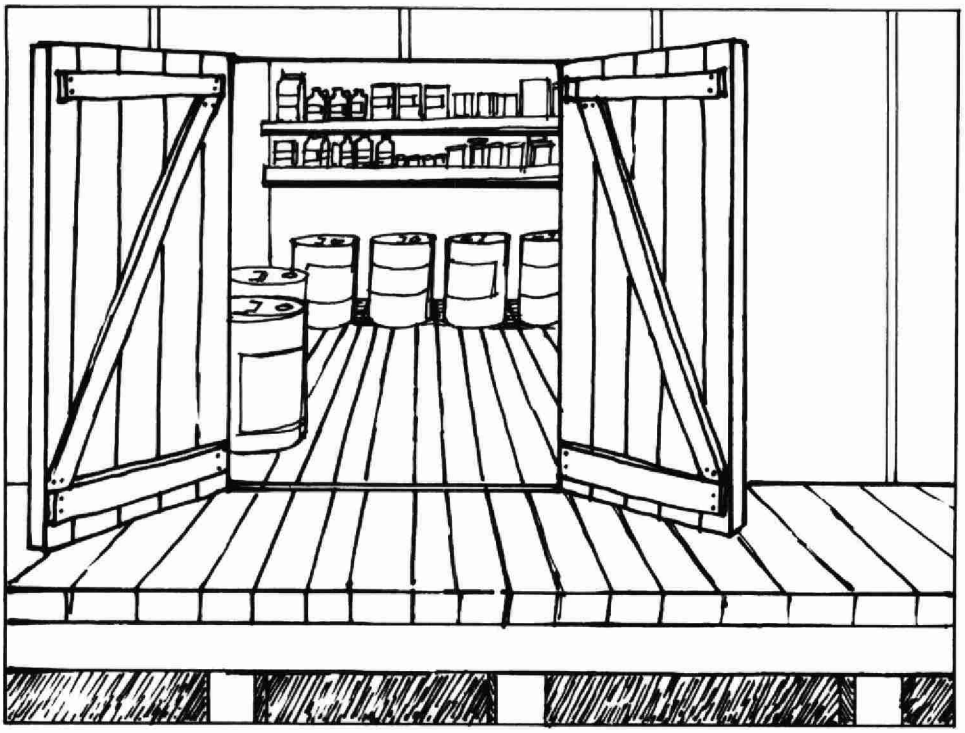
Disposal of Surplus Pesticide

Take steps to safely dispose of those pesticides which cannot be used or are not required. It is sometimes possible to return unused pesticides to the supplier if the pesticide is still in its original container. Another possibility is to give the unwanted pesticide to another farmer who can use it. If the local supplier or nearby neighbours are not willing to accept the surplus pesticides, read the pesticide's label. The label will give the pesticide's classification - domestic, agricultural or restricted. If the pesticide has been classified for "Domestic" use it can be disposed of in the municipal solid waste dump. Take some precautions prior to dumping. Wrap the container in several layers of newspaper and place it in a plastic bag that is tied closed. If the package cannot be disposed of right away, keep it safely stored in the pesticide storage area. However, if the surplus pesticide is **not** classified as a domestic product it is best to contact the Pesticide Officer at the local Ontario Ministry of the Environment office. He will be able to give advice on how to properly dispose of the pesticide. If the surplus pesticide is **unlabelled** be certain to call the local Ministry of the Environment office prior to disposal. Unlabelled pesticides are of unknown hazard and should be disposed of with greater caution.



STORAGE & SPILLS ACTION

No pesticide application is complete until all the pesticides, the empty containers, and the spray equipment have been stored or disposed of properly. Make it a habit that all spraying materials are safely stored at the end of the day or before going on to the next job.



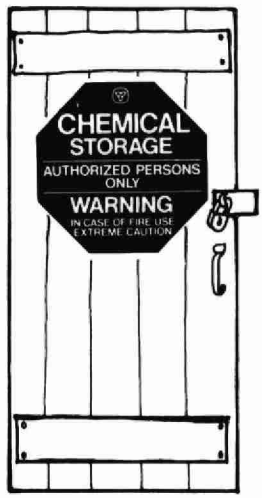
Proper storage of pesticides on the farm is important. Actually, it is **illegal** under the Pesticides Act for a farmer to store pesticides under unsafe conditions. Follow the government's pesticide storage regulations and prevent accidents from happening in the pesticide storage.

> No person shall store any pesticide in such a manner that the pesticide is likely to come into contact with food or drink intended for human or animal consumption (Pesticides Act, 1980, Reg. 751, s. 98)

PESTICIDE STORAGE REGULATIONS

Be careful when choosing a site for pesticide storage. Pesticides can accidentally contaminate water or food when they are stored in close proximity to each other. Remember that pesticides should never be stored, not even for a short time:

- in barns close to livestock
- with grain, hay or other animal food
- in a fruit or vegetable storage
- in milk houses
- over or near wells, cisterns, or water supplies
- in the home



Every person responsible for a Schedule 1, 2 or 5 pesticide shall ensure that:

a) any room in which the pesticide is stored is ventilated to the outside atmosphere

b) a placard is affixed and maintained on the outside of each door leading into the room in which pesticide is stored bearing the words "Chemical Storage Warning - Authorized Persons Only" in block letters clearly visible.

(c) no person can enter the room in which the pesticide is stored without the express permission of the person responsible (Pesticides Act, 1980, Reg. 751, s. 99)

If a farmer wishes to store the more toxic pesticides, Schedule 1, 2 or 5 pesticides, he must take extra precautions in his storage area.

a) Outside ventilation will be needed to help lower the level of fumes in the storage area.

b) It will be necessary to place a chemical warning sign on each door that opens into the storage area. These warning signs are readily available at the local Ontario Ministry of Agriculture and Food or Ontario Ministry of the Environment office.

c) The storage area should be kept locked. This will prevent children and other unauthorized persons from coming into contact with the stored pesticides.

THE STORAGE BUILDING

Avoid having several pesticide storage sites scattered around the farm. Select one building or a specific section of a building to act as the pesticide storage area. If large amounts of pesticides are used a special facility can be built for these pesticides.

Site Selection

Before choosing an area within an existing building or beginning construction consider the advantages or disadvantages of a number of possible sites. The site that is eventually selected should be isolated. Not only isolated from playing children but from any area that is sensitive to pesticides such as areas that store food/feed or house livestock. Avoid sites where there is any chance that runoff or drainage water from the pesticide storage area may enter surface or ground water.

Storage Requirements

The area or building used for pesticide storage should have a floor that does not allow seepage - a concrete or asphalt floor is best. Drains are only possible if they lead into a separate holding tank which can be pumped out. Windows should be installed if the building has no means of mechanical ventilation. Unauthorized persons must be kept from entering the storage area. Make certain that the area can be securely locked and that the necessary warning signs are on all storage doors. It is a good idea to have emergency equipment close at hand - fire extinguisher, absorptive material, broom/dust pan, and most importantly adequate protective clothing and equipment. Do not place protective clothing and equipment in the storage area where it may become contaminated. Post the emergency telephone numbers for quick reference.

- fire department
- police
- hospital
- ambulance
- physician
- local Ministry of the Environment office.

Storage Conditions

Pesticides should be stored in areas that are dry. Moist storage conditions will cause containers to rust and bags to split, causing spills and loss of pesticides. Pesticide labels may deteriorate with moisture and be impossible to read -a loss of essential information. Storage temperature rarely needs control. There are, however, some pesticides that require protection from freezing if stored over the winter. If holding such pesticides over until the next season it will be necessary to

winterize the storage area. Normal summer temperatures usually present no hazard to stored pesticides. Chemical manufacturers formulate their products to withstand these summer temperatures. Read the pesticide label - it will indicate any special temperature requirements for storage.

Not only is it important **where** pesticides are stored but **how** they are stored.

STORAGE PRACTICES

Storage Layout

Do not store herbicides and other pesticides close together. A herbicide may accidentally become mixed with other nearby pesticide (contamination). When the contaminated pesticide is used to control a pest problem the herbicide in it may injure or kill the crop. It is a good idea to place all the highly toxic pesticides together in a remote area of the storage. If children do enter the storage they will then be less likely to come into contact with the more hazardous products. People using these pesticides will also have a constant reminder that special safety precautions are necessary when handling pesticides from this section of the storage.

Good Housekeeping

Know the quantity and the age of the pesticides in storage by keeping current inventories. Write the year of purchase on the pesticide label. Estimate pesticide needs for each season taking inventory into account. Remember to use any of last year's pesticide first. Never buy and store more pesticide than what is required for a single season. Pesticides must be kept in their original, labelled containers. However, pesticide containers may become damaged in storage. Make routine inspections of containers. Look for rust, leaks, loose caps or bungs. If a damaged container is found it will then be necessary to remove the pesticide from its original container. Place the pesticide in a container* that is similar to the original, (i.e. plastic replaced with plastic). Label the new container with the pesticide's

- trade name
- common name
- the concentration of each active ingredient in the formulation, and
- the Pest Control Products Act registration number

When dealing with a damaged bag, place it inside a clean plastic bag, close and label with the necessary information. Sometimes it is possible to take the label from the damaged container and attach it to the new container. Unlabelled pesticides are dangerous and illegal. Without the label you neither know what the pesticide is nor how to handle it safely. Contact the Pesticide Officer at the local Ontario Ministry of the Environment office. He will know how to properly dispose of the unlabelled pesticides in the storage area.

ACCIDENTS

In spite of all precautions, accidents can happen in a pesticide storage. It is important to act quickly when an accident does occur. Learn how to properly deal with both pesticide spills and fires.

*Never store pesticides in any container that was previously used to hold a food or beverage. Pesticides in old food/beverage containers are often mistaken as a food/beverage and are accidentally swallowed especially by small children.

Spills
During a routine check of the storage area a damaged container may have allowed pesticide to leak out. Before beginning to clean up the spill, remember to protect against pesticide exposure. Ventilate the storage area and make sure that the proper protective clothing and equipment is worn. Once protected, stop the container from leaking. A container holding liquid pesticide may need to be inverted or the contents poured into another suitable container. A leaking bag of dry pesticide can be put directly into another bag. Once the leak has been controlled begin to clean up the spilled pesticide.

For Liquid Spill

- cover spill with a thick layer of absorptive material (soil, vermiculite, kitty litter, etc.)
- allow pesticide to be soaked up by the absorptive material
- sweep or shovel absorptive material into a waste drum

For Dust, Granular, or Powder Spill

- sweep or shovel into waste drum

To Decontaminate the Spill Area

- cover spill area with 1:1 bleach/water solution (hint: a dike of absorptive material will stop the bleach solution from spreading)
- cover bleach with hydrated lime and let bleach/hydrated lime mixture stand for 1-2 hours
- sweep or shovel lime and bleach into waste drum
- seal the waste drum and store until its contents can be properly disposed of by burying materials under at least 50 cm. of soil. **Never** bury cleanup material near watercourses or in areas with high water tables.

If the spill occurred on soil, it may be necessary to dig up and remove the contaminated soil. Dispose of the soil in a similar manner to that of the cleanup materials.

Check surrounding containers for possible contamination from the spilled pesticide. It may be possible to decontaminate metal or plastic containers with a mixture of bleach and water. It is best to throw out any pesticide (especially those in paper containers) that cannot be decontaminated. Before leaving the storage area remember to correctly label the new container of pesticide.

Major pesticide spills may occur. The first and most important priority is to remove any person or animal from the spill area. If they have come in contact with the pesticide stop their exposure. Remove contaminated clothing and wash affected skin with lots of soap and water. Stop unprotected people from entering the spill area. If the spill poses a hazard to man or to the environment, call the Spills Action Centre. They will know how to properly deal with the spill. It is essential to contain the spill - do not let the pesticide enter any watercourse. Once you have contained the spill, follow the clean-up guidelines outlined for minor spills.

Fires
Fires in pesticide storage areas are very dangerous. There is the hazard of the fire itself plus the hazard that some pesticides may release highly toxic fumes when burnt. It is suggested, in the interest of safety to local fire-fighters, that a grower tell his local fire department that he does store pesticides.

If a fire occurs, keep people away from the area so that they do not breathe in the toxic fumes. Remind fire fighters of the additional danger of burning pesticides. Recommend that to safely protect themselves they wear air-supplied respirators and rubber clothing. Warn them to use as little water as possible to fight the fire. Foam or fog nozzles are recommended when fighting a pesticide fire. Any runoff water from the fire must be contained since it will likely hold pesticide.

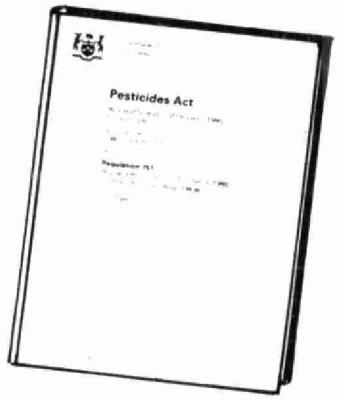
ALUMINUM PHOSPHIDE

Aluminum phosphide is a toxic pesticide which can be hazardous if not used properly. It effectively controls groundhogs and all life stages of food storage insects. Aluminum phosphide can be used on the farm for both groundhog control and grain bin fumigation. Safe use of this pesticide requires that special precautions be taken by the user.

Aluminum phosphide is formulated with ammonia carbamate to form tablets or pellets. Upon opening a container, ammonia and carbon dioxide are released (developed from the unstable ammonium carbonate) producing a pungent carbide-like warning gas. The tablet/pellet decomposes as it comes in contact with moisture and releases the deadly phosphine gas. The fumigant provides a further warning agent to the user due to its garlic-like odour. A paraffin coating ensures that the fumigant will not develop immediately upon exposure to air. Gas development will commence about 2-3 hours after air exposure of the tablets and 1-2 hours after the pellets are exposed to the atmosphere. When handling aluminum phosphide tablets or pellets it is important that cotton gloves or disposable surgical gloves be worn. Bare hands or loose fitting rubber gloves may allow moisture to come in contact with the pesticide.

LEGISLATION

The availability of aluminum phosphide to the grower is regulated by Ontario's scheduling system. All aluminum phosphide products registered for the control of groundhogs are placed in Schedule 5 and these are readily available to the farmer. Aluminum phosphide products registered for food storage insect control are placed in Schedule 1. Before using any product classified in Schedule 1 a grower must apply for a use permit through a regional office of the Ministry of the Environment. Prior to issuing a permit for any Schedule 1 product, the Ministry may require the applicant to fulfill specific requirements. For farmers wishing to use aluminum phosphide for grain bin fumigation for the first time, the Ministry will consider the issuance of a permit. If the grower wishes to purchase and use the product on subsequent occasions, the Ministry will require the user to hold a structural class 6 endorsed licence for aluminum phosphide in vertical grain bins. It is important to realize that although groundhog control products are in Schedule 5 and bin fumigating products are placed in Schedule 1 - both products are equally hazardous to man, domestic animals and wildlife. Placing the groundhog control products in Schedule 5 allows the product to be more readily available to the experienced agriculturalist. Remember that equal safety and use precautions must be taken with all aluminum phosphide products no matter what schedule they are placed in.



TOXICOLOGY

Aluminum phosphide is a very effective pesticide product - the phosphine gas it releases is toxic to all forms of insect and animal life including man. This chemical does not readily penetrate the skin but may be fatal through ingestion or inhalation. The ingestion of an aluminum phosphide tablet or pellet is a rare occurrence, however it can occur accidentally. Ingestion can be prevented by keeping the product in its originally labelled container in a locked pesticide storage. Inhalation exposure to phosphine can occur if the applicator neglects to follow the safety precautions on the label.

Acute Toxicity

Phosphine does have the ability to cause acute toxicity in users. Acute toxicity is a pesticide's ability to cause poisoning after a single exposure to the chemical. Since phosphine does not readily enter dermally and oral ingestion is unlikely, acute poisoning normally occurs when the gas is breathed in. The time-weighted average threshold limit value (TWA-TLV) has been established for phosphine to

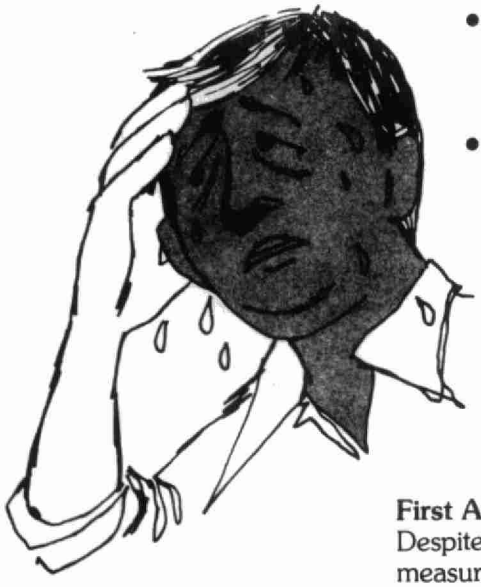
be 0.3 ppm in air by volume or 0.4 mg/m³. This TWA-TLV refers to the average concentration for a normal eight hour work day and a 40 hour work week to which nearly all workers may be repeatedly exposed, day after day, without adverse effects. On the farm this figure is of no value, being of more concern to commercial fumigators. Of more importance to the grower is the short-term exposure limit threshold limit value (STEL-TLV). The STEL-TLV is the concentration of phosphine to which a person can be exposed without experiencing poisoning symptoms. The STEL-TLV for phosphine is 1 ppm or 1 mg/m³. Studies have found that human exposure to 7 ppm of phosphine will cause definite poisoning symptoms. Exposure to 200 ppm is fatal within 60 minutes and exposure to 400 ppm is rapidly fatal. In typical farm situations concentrations during groundhog control would rarely reach the STEL-TLV of 1 ppm. There is a greater chance of encountering dangerous levels of phosphine in enclosed areas - such as grain bins.

POISONINGS

Symptoms

Symptoms may either occur immediately or after several hours, depending on the amount of phosphine inhaled.

- Symptoms of poisoning by a small quantity of phosphine would be: fatigue, ringing in the ears, nausea, pressure in the chest and uneasiness. All of these symptoms will normally disappear with exposure to fresh air.
- Exposure to greater quantities of phosphine will rapidly lead to: extreme fatigue, severe nausea, vomiting, stomach pains, diarrhea, strong chest pains and difficulty in breathing.
- Exposure to high concentrations of phosphine will very quickly lead to: skin becoming bluish-purple, agitation, difficulty in walking/reaching, unconsciousness and death.



First Aid

Despite the seemingly insignificance of even mild cases of poisoning, first aid measures are absolutely imperative before and until the arrival of a doctor. First aid steps are:

a) Move the victim to open air.

b) Treat as for shock. Make patient lie down in a comfortable position and keep warm.

FIRST AID

c) Tell the doctor (who had been sent for immediately) whether the patient has had nausea or has vomited.

d) Administer artifical respiration if breathing has stopped.

e) Make NO antidotal use of fats, oil, butter or milk.

Remember, after inhalation of phosphine, the person must be immediately taken into open air, laid down and kept warm and quiet. If a slight poisoning has occurred a person will recover quickly - within one to two hours. However, this person should not resume working during the next 48 hours, particularly work dealing with fumigation and ventilation.

GROUNDHOG CONTROL WITH ALUMINUM PHOSPHIDE

Groundhogs must be exposed to the phosphine gas for a sufficient period of time in order to kill them. Follow the guidelines below.

1. In fall mark burrows for spring treatment. This includes main entrance, escape hole and location of false burrows.

2. Prior to treatment expose all burrow openings fully. Do not use aluminum phosphide in burrows that are in or around buildings.

3. Place aluminum phosphide tablets in the burrow as far as possible. This is best accomplished by using a piece of poly-tubing to pass the tablets down into the burrow. Natural moisture in the burrow will be sufficient to release the gas. DO NOT ADD WATER.

4. Fill in the hole with soil and tamp it down. Do NOT cover tablets with soil.

5. Dispose of empty containers under 50 cm of soil, away from any water-course.

Whenever handling aluminum phosphide remember to:

1. read the label

2. open containers in the open air

3. wear COTTON, not rubber, gloves whenever handling the tablets

4. do not smoke or eat while handling

5. use all of the contents at the same time and dispose of the empty container properly

6. wash hands after use

7. keep tablets away from moisture, open flames and heat

8. do not use in or around occupied buildings

9. have a full face gas mask with a canister approved for phosphine gas

10. always work in pairs

VERTICAL SILO BIN FUMIGATION

Phosphine gas can penetrate densely packed food commodities. This same trait lends itself to good aeration of fumigated commodities. Any brick, concrete or steel silo bin with grain recycling facilities that are closed on all sides and sufficiently gas-tight are suitable for an aluminum phosphide fumigation. Farm silos made of wood or loosely constructed metal should be covered with polyethylene.

Before the silo is fumigated, the user should determine:

1. the average temperature of the bin/silo

2. the humidity of the food/feed and

3. the type of pests requiring control.

This information will help determine the proper and most effective dosage rate

and exposure time. Consult your supplier or Canadian registrant for this information.

Distributing the aluminum phosphide pellets into the grain can occur in one of three ways as the grain is being fed into the silo:

- use of a pellet dispenser
- manually dropped onto conveyor belt
- manually dropped through manhole or feed tube into the commodity's stream.

The pellets should be handled with care. Wear cotton gloves or throw-away surgical gloves. If there is any possibility of inhalation exposure wear a full-face gas mask with a canister approved for phosphine gas . Do not work alone, always work in pairs.

STORAGE

If open-topped bins have a large cross-section and are already filled, they can be treated by injecting pellets into the grain with a probe and covering the bin with polyethylene. Even distribution throughout the grain is essential.

Aluminum phosphide tablets are packed in aluminum tubes with tight plastic stoppers which are encased in strong gas-tight tins. Pellets are packaged in a gas-tight aluminum flask. Both of these containers should be kept in a dry, reasonably cool, ventilated and locked storage. As long as the packing remains intact the shelf life is practically unlimited.

If less than a whole container is used, it should be resealed tightly and kept in a secure, dry, cool, well ventilated storage. NEVER refrigerate, as condensation may occur once the container has been opened.

ONTARIO MINISTRY OF THE ENVIRONMENT PESTICIDES CONTROL FIELD OFFICES

COUNTIES	FIELD OFFICES	TELEPHONE
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Halton, Peel, York, Durham, Toronto, Simcoe, Muskoka	7 Overlea Blvd. Don Mills, M4H 1A8	(416) 424-3000
Peterborough, Victoria, Haliburton, Northumberland	139 George Street N. Peterborough, K9J 3G6	(705) 743-2972
West Central Region		
Haldimand, Norfolk, Niagara, Hamilton-Wentworth, Dufferin, Wellington, Waterloo, Brant	Ontario Gov't Bldg. 119 King Street W. Hamilton, L8N 3Z9	(416) 521-7640
Southwestern Region		
Elgin, Middlesex, Oxford	985 Adelaide St. S. London, N6E 1V3	(519) 661-2200
Essex, Kent, Lambton	P.O. Box 726 435 Grand Ave. W. Chatham, N7M 5L1	(519) 354-2150
Bruce, Grey, Huron, Perth	20 King Street P.O. Box 688 Ont. Ministry of Agr. & Food Bldg. Clinton, N0M 1L0	(519) 482-3428
Southeastern Region		
Frontenac, Hastings, Lennox & Addington, Prince Edward, Leeds & Grenville	P.O. Box 820 133 Dalton Street Kingston, K7L 4X6	(613) 549-4000
Prescott & Russell, Renfrew, Stormont, Dundas & Glengarry, Ottawa-Carleton, Lanark	2378 Holly Lane Suite 204, Ottawa, K1V 7P1	(613) 521-3450
Northeastern Region		
Manitoulin, Nipissing, Parry Sound, Sudbury, Cochrane, Timiskaming, Algoma	199 Larch Street Sudbury, P3E 5P9	(705) 675-4501
Northwestern Region		
Kenora, Rainy River, Thunder Bay	Ontario Gov't. Bldg. 435 James Street S. Thunder Bay, P7B 5G6	(807) 475-1215
Head Office	Ag. & Ind. Chemicals Section 135 St. Clair Ave. W. Suite 100 Toronto, M4V 1P5	(416) 323-5095

CONVERSIONS FROM IMPERIAL AND U.S. TO METRIC MEASURES

Imperial or U.S. Units	x Conversion Factor	= Metric Units
Length		
inches	x 2.54	= centimetres (cm)
feet	x 30.5	= centimetres (cm)
yards	x 0.91	= metres (m)
miles	x 1609	= metres (m)
miles	x 1.61	= kilometres (km)
Area		
square inches	x 6.45	= square centimetres (cm^2)
square feet (ft^2)	x 0.093	= square metres (m^2)
square yards (yd^2)	x 0.84	= square metres (m^2)
acres	x 4,047	= square metres (m^2)
acres	x 0.405	= hectares (ha)
Volume		
teaspoons (Imp.)	x 4.74	= millilitres (mL)
tablespoons (Imp.)	x 14.2	= millilitres (mL)
fluid ounces (Imp.)	x 28.41	= millilitres (mL)
fluid ounces (U.S.)	x 29.57	= millilitres (mL)
pints (Imp.)	x 0.57	= litres (L)
quarts (Imp.)	x 1.14	= litres (L)
gallons (Imp.)	x 4.55	= litres (L)
gallons (U.S.)	x 3.79	= litres (L)
cubic feet	x 28.32	= litres (L)
cubic inches	x 16.39	= cm^3, mL, cc
cubic feet	x 0.03	= m^3
cubic yards	x 0.77	= m^3
bushels	x 36.4	= litres (L)
Weight		
ounces	x 28.35	= grams
pounds	x 0.45	= kilograms
short tons (2,000 lb.)	x 0.91	= tonnes (1,000 kg.)
Speed		
miles per hour (mph)	x 1.609	= kilometres/hour (km/h)
feet per second	x 30.48	= metres/second (m/sec)
Pressure		
pounds per square inch (psi)	x 6.895	= kilopascals (K Pa)
Proportions		
ounces/acre	x 70.05	= grams/hectare (g/ha)
pounds/acre	x 1.12	= kilograms/hectare (kg/ha)
fluid ounces/acre (Imp.)	x 70.21	= millitres/hectare (mL/ha)
pints/acre (Imp.)	x 1.40	= litres/hectare (L/ha)
gallons/acre (Imp.)	x 11.23	= litres/hectare (L/ha)
gallons/acres (U.S.)	x 9.35	= litres/hectare (L/ha)
bushels/acre	x 90	= litres/hectare (L/ha)
plants/acre	x 2.47	= plants/hectare (plants/ha)
teaspoons/gallon (Imp.)	x 1.04	= millitres/litre (mL/L)
tablespoons/gallon (Imp.)	x 3.12	= millitres/litre (mL/L)
fluid ounces/gallon (Imp.)	x 6.25	= millitres/litre (mL/L)
pounds/gallon (Imp.)	x 0.10	= kilograms/litre (kg/L)
ounces/square foot	x 305	= grams/square metre (g/m^2)
pounds/square foot	x 4.88	= kilograms/square metre (kg/m^2)
ounces/foot row	x 93.01	= grams/metre row
pounds/foot row	x 1.49	= kilograms/metre row

METRIC UNITS

Weight is measured in grams (g)
one kilogram (kg) = 1,000 grams
one milligram (mg) = 1/1,000 or 0.001 gram

Volume is measured in litres (L)
one millilitre (mL) = 1/1,000 or 0.001 litre

Note the relation of these units as follows:

1.0 kg	=	1,000 g	1.0 L	=	1,000 mL
0.1 kg	=	100 g	0.1 L	=	100 mL
0.01 kg	=	10 g	0.01 L	=	10 mL
0.001 kg	=	1 g	0.001 L	=	1 mL

1 hectare = 10,000 sq. metres
(1 acre = 43,560 sq. feet)

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GLOSSARY OF TERMS

a.i. Active ingredient in a pesticide formulation.

absorbent material A special type of material which can take up chemicals and hold them. Sometimes used to clean up pesticide spills. Example: clay powder.

absorption Movement into a plant, animal, or soil of a substance placed on its surface.

accumulate Pesticides that tend to build up in animals or the environment.

acetylcholine A chemical conductor formed at the ends of nerves, to conduct nerve impulses over the microscopic gap between nerves or between a nerve and a muscle or gland.

activated charcoal A finely ground form of charcoal used to absorb gases and vapours in cartridge respirators.

active ingredient (a.i.) The part of a pesticide formulation which is the actual toxic agent.

acute exposure A single exposure to a substance or multiple exposures occurring within a short time, usually during a working day.

acute poisoning Severe poisoning which occurs after one exposure to a pesticide.

acute toxicity The toxic response resulting from a single dose or single exposure to a pesticide. Determined through oral, dermal or inhalation studies.

adjuvant A substance added to a pesticide mixture to improve effectiveness of the active ingredient. Examples: emulsifiers, penetrants, wetting agents, stickers, synergists.

aerosol (pressurized can) Pesticide driven by an inactive gas under pressure, producing very fine solid or liquid particles suspended in air.

agitation The movement of a liquid pesticide to keep the contents mixed.

air blast sprayer An applicator which propels spray droplets in an airstream, used for spraying orchards.

air gaps The physical separation of a drinking water system from a contaminated system by a vertical air space.

air-purifying respirator Respirator fitted with charcoal filters and dust collectors to remove pesticide from the air before breathing.

antidote A remedy given by a doctor to counteract the effects of a poison.

anti-siphoning device (atmospheric vacuum breaker) A device attached to a filling hose to prevent water in the spray tank from draining back into the water source.

artificial respiration (A.R.) First aid method to establish and maintain breathing.

atropine A drug administered by a doctor to those poisoned by organophosphorous and carbamate insecticides.

biological control The use of living things such as predators, to control pests.

boom sprayer — An application that delivers spray droplets through nozzles on a boom (pipe or tube) and directs onto the soil or crop canopy. Most common type of sprayer.

bucket (trombone) sprayer — A double action hydraulic pump used to apply liquid pesticides from a separate container.

canister gas mask — A metal or plastic container filled with absorbent materials, and designed to filter gases and vapours from the air before breathed by the applicator. The canister may also contain a physical filter to remove solid or liquid particles.

CANUTEC — Canadian Transport Emergency Centre established to give information on chemicals. Operated by Transport Canada.

carbamate insecticide — Organic pesticides that can have similar toxic effects as organophosphorous insecticides.

carcinogenicity — The production of cancer, i.e. new or abnormal growth such as a tumour.

cartridge — The small, detachable part of the air-purifying respirator which is designed to absorb gases and vapours from air before breathing.

caustic — A corrosive chemical that can burn the skin. Caustics have pH values less than 7.

cholinesterase — An enzyme found in humans that eliminates acetylcholine after the passage of a nervous impulse. Cholinesterase is necessary for the proper functioning of the nervous system. Organophosphorous and carbamate insecticides are cholinesterase inhibitors.

cholinesterase level — Individuals have their own level of cholinesterase in their blood.

chronic exposure — Repeated exposure to a substance over a relatively longer period of time.

chronic toxicity — The toxic response resulting from repeated exposure to small doses of pesticide over a long period of time.

classification (scheduling) — (a) The system used in Ontario to classify federally registered products by their toxicity and environmental and health hazards. It restricts the access of pesticides in Ontario.

(b) Federal system to group products by use and toxicity as either DOMESTIC, COMMERCIAL, RESTRICTED or MANUFACTURING.

common name (CSA chemical name) — The simplified chemical name of the active ingredient of a pesticide appearing on the label as the guarantee (as called generic name).

compatibility — When two or more pesticides are added to a spray tank, mix satisfactorily and, when combined, work effectively together.

compressed-air sprayer — A vacuum drawing a fixed rate of pesticide from a small spray tank to mix with water flowing through a hose.

concentrate — The pesticide formulation sold by the vendor to the user before being diluted with water or oil. Opposite of dilute.

confined space — An enclosure or partial enclosure having limited means of entry or exit, with poor natural ventilation. Confined spaces may contain hazardous contaminants or be oxygen-deficient, e.g. mushroom houses, greenhouses. All confined spaces are considered immediately dangerous to life or health unless proven otherwise.

contaminate — To alter a material by the introduction of a chemical, so that it is unfit for a specified use.

contravention Violation or conflict.

corrosive A substance that contains an acid or caustic which may chemically burn the skin, mouth, stomach, etc. Corrosives may also attack metal parts (e.g. metal pesticide application equipment and storage containers).

cultural control Pest control method using practices common to good land management.

days to harvest The least number of days between the last pesticide application and the harvest date as set by law.

decontaminate To remove pesticide residues by (a) washing with water, (2) absorbing, or neutralizing with sand, soil, charcoal or (3) removing.

dermal Related to the skin.

dermatitis Inflammation of the skin induced by contact with some agent.

dilute To make a pesticide concentration weaker by adding water, oil or inert solids.

drift Airborne movement of pesticide droplets or particles away from the target area to areas not treated.

dry flowable A wettable powder which is formulated into small pellets or granules.

dust or powder A finely ground dry material of a low concentration (a.i.) plus inerts such as talc. No dilution needed before use.

efficacy The production of a desired effect.

emulsifiable concentrate A liquid pesticide formulation consisting of the active ingredient, a solvent, and an emulsifier to facilitate mixing in water to form an emulsion.

entomologist A person who studies insects.

exposure Contact or presence of a gas, liquid or solid on an applicator or bystander, which can be oral, dermal or respiratory.

face shield A transparent piece of protective equipment used by an applicator to protect the face from pesticide exposure.

formulation The form in which a pesticide is sold and includes the active ingredient, carriers, diluents, or other materials.

fumigant Pesticides used in the form of volatile liquids or gases.

fumigation The use of pesticides in gaseous form to destroy pests. Fumigation may be carried out either indoors or outdoors.

fungi (fungus) Group of small organisms which cause rots, mold and plant diseases.

fungicide Pesticides used to control fungal plant diseases.

gas A substance that is in the gaseous state at ordinary temperature and pressure.

granular A mix of dry, large, free-flowing particles usually with a low concentration of a.i.

guarantee The amount of active ingredient in a product as stated on the label usually expressed as a percentage by weight or weight per unit volume.

hand pump sprayer Hand operated plunger, pesticide is forced out with the air-flow.

hazard The danger of exposure when working with pesticide.

herbicide A pesticide used to control or kill weeds.

hose end sprayer A vacuum drawing a fixed rate of pesticide from a small spray tank to mix with water flowing through a hose.

hydraulic sprayer Spray equipment which delivers pesticide as a spray driven by a hydraulic pump.

impregnated fertilizer Granular fertilizer containing low amount of herbicides.

inert ingredient Any ingredient in a formulation which has no pesticidal action but some can be toxic to the applicator.

ingestion Take through the mouth and swallow.

inhalation Take through nose when breathing air into the lungs.

insecticide A pesticide used to control or kill insects.

irritant A substance which produces symptoms of inflammation on contact with the skin, eyes, nose, throat, lungs and stomach. Inflammation of the skin is called dermatitis.

LC_{50} (lethal concentration to 50% of a population) The concentration of a pesticide in the air or water sufficient to kill half of the test animals exposed for a predetermined period of time, (usually 60 hours).

LD_{50} (lethal dose 50%) A statistical estimate of a chemical dose which will kill 50 percent of test animals, usually within a stated period of observation.

maximum residue limit (MRL) Established by Health & Welfare Canada and expressed in parts per million. The largest amount of residue allowed, based on toxicity of the pesticide, its application rate and timing and the crop to which it is being applied.

metabolism Processes occurring in organisms or cells.

micro-encapsulated A suspension with a.i. in micro-capsules giving a slow release of a.i.

mist blower (low volume air sprayers) Equipment to apply suspended droplets in air, generated when a liquid is broken up or dispersed. They use low water volumes.

mite A tiny animal, similar to a spider, having 8 legs.

miticide A pesticide used to control or kill mites, also termed acaracide.

mutagenicity A mutation or genetic change in a cell.

negative fit check A check to be sure that a respirator fits properly.

nematocide A pesticide used to control or kill nematodes.

nematode A tiny round worm that causes damage by feeding on roots or other plant parts.

neoprene Synthetic rubber-like polymer.

NIOSH The U.S. National Institute for Occupational Safety and Health. NIOSH operates a testing and certification program for respirators.

noxious	Harmful.
ocular	Concerning the eyes.
oral	Taken into the body through the mouth.
organochlorine insecticides	Organic chemicals containing chlorine, e.g. endosulfan, dicofol.
organophosphorous insecticides	Synthetic organic insecticides which contain phosphorous, giving acute toxic effect due to inhibition of the enzyme cholinesterase.
particulate or bait	Mixture of large particles not recognized as a pellet or granular formuation. Mixed with edible inerts.
parts per million (ppm)	A measurement of a minute amount of pesticide residue usually in milligrams per kilograms.
pathologist	Person who studies diseases.
pellet	Preformed mixture of a.i. and inerts to form spheres or cylinders.
pest	Undesirable organism.
Pest Control Products Act	The Act administered by Agriculture Canada requiring a pesticide to be adequately tested before registration and sale. The pesticide product must carry a registration number before legal sale.
pesticide	Any device, substance or mixture of substances intended for killing, controlling or managing pests, ie. insects, rodents, fungi, weeds, and other forms of life.
Pesticides Act	The Act regulating pesticides in Ontario. Under the Act, all pesticides registered for sale federally must be classified in Ontario into one of six schedules.
photo-allergic	Allergic response to pesticides, activated by sunlight.
physical control	Removing the pest from the crop by pruning, cultivation, etc.
poison	A chemical which when taken in small quantities, causes illness or death.
Poison Information Centres	Located in all Provinces, Centres provide first aid information for poisoned victims, and antidotes and treatment procedures to doctors.
powered air purifiers	A helmet system respirator having a motor-blower which forces air through a filter.
pre-harvest interval	Days between the pesticide application date and harvest date. Minimum interval allowed appears on the label.
principal display panel	Front panel of a pesticide label.
P.V.C.	Polyvinylchloride - a form of vinyl used in manufacturing.
re-entry time	The length of time that must pass before a worker not wearing suitable protective clothing is permitted to enter an area to which a pesticide has been applied.
registered pesticide	A pesticide accepted under the Pest Control Products Act for the uses and purposes claimed. The PCP registration number must be displayed on the label of each pesticide container sold or used in Canada.
registrant	Person or company having registered a product.

residue The amount of pesticide that remains on a crop, animal or surface for a period of time after it has been treated.

residue tolerances The maximum level of residues that may lawfully be on, or in, food.

respirator A device designed to protect the wearer from inhalation of hazardous air. Respirator covers wearer's nose and mouth **quarter-facepiece** (above the chin), **half-facepiece** (under the chin), **full-facepiece** covers nose, mouth and eyes. It is designed to make a gas-tight or particle-tight fit with the face and includes the head harness, exhalation valve(s), and connections for an air-purifying device or a respirable gas source or both.

rinsing device Device available which uses pressurized water to rinse containers as effectively as triple rinsing.

risk The magnitude of harm resulting from exposure and the possibility of it occurring.

rodenticide A pesticide used to control or kill rodents.

secondary display panel The back or side panel of a pesticide label.

seed treatment A finely ground dry material containing a dye, usually red.

sensitive crops Crops which are easily injured by pesticide chemicals - even slight drift can cause problems.

sensitizer A substance which on first exposure causes little or no reaction, but which on repeated exposure may cause a marked response not necessarily limited to the contact site. Skin sensitization is the most common form of sensitization, although respiratory sensitization is also known to occur.

smoke bombs A form of pesticide which on burning releases aerosols, gases, and vapours to fumigate greenhouses and mushroom houses.

soil fumigant A pesticide used to control pests in the soil. When added to the soil, it takes the form of a gas or vapour. Since it can evaporate quickly, it is often used with some kind of cover.

soluble powder or granules A dry material similar to dust or granules except it is soluble in water.

solvent An organic liquid used to dissolve non-water soluble substances.

Spills Action Centre A centre established to receive calls reporting spills and to provide information concerning clean-up. Operated by the Ontario Ministry of the Environment -1-800-268-6060.

supplied-air respirator These respirators supply air through a tube to the headpiece from a tank on the wearer's back (Self Contained Breathing Apparatus).

suspension or flowable A cloudy liquid composed of solid particles of a.i. (finely ground) in a liquid. Needs dilution.

symptom An outward sign of a disease or poisoning.

synapse A gap between one nerve fibre and another.

synergism The increased effectiveness achieved when two chemicals are used together, compared to their effectiveness when used alone.

syrup of ipecac — A syrup made from the roots of ipecac plant used to induce vomiting.

tablet — A preformed "tablet" composed of inerts and a.i.

technical material — The pesticide (active ingredient) as it is manufactured by a chemical company before formulation.

teratogenicity — The production of abnormalities in developing organisms.

test animals — Laboratory animals exposed to pesticides to measure toxicological effects - rats, mice, rabbits, birds or fish.

toxicity — The ability of a substance to cause human injury, sickness or other unwanted effects. Toxicity is distinct from hazard.

trade name — A name given to a product by the manufacturer to identify it.

Transporation of Dangerous Goods Act — A federal act, administered by Transport Canada, promoting public safety in the transportation of dangerous goods. Many pesticides are classed as dangerous goods.

trigger pump sprayers — Pesticide mixture forced through nozzle when trigger is squeezed.

triple rinse — Method of properly rinsing containers by filling the container 10% full with diluent, then capping, shaking the container and adding the rinsate to the spray tank. Repeated two more times.

true liquid/solution — A.i. is in solution, usually water and when mixed with water remains clear.

ULV (ultra low volume) — A spray applicaton of a pesticide that is almost pure active ingredient. Application rates are only 5 to 6 L/ha or less.

ULV sprayers — Ultra low volume sprayers used to apply pesticide that is almost pure active ingredient.

volatility — Refers to the ease with which a material evaporates.

wettable powder — A.i. added to powder (clay, talc) containing a wetting and dispersing agent. Forms a suspension in water.

wetting agent — An adjuvant added to pesticides to promote spreading.

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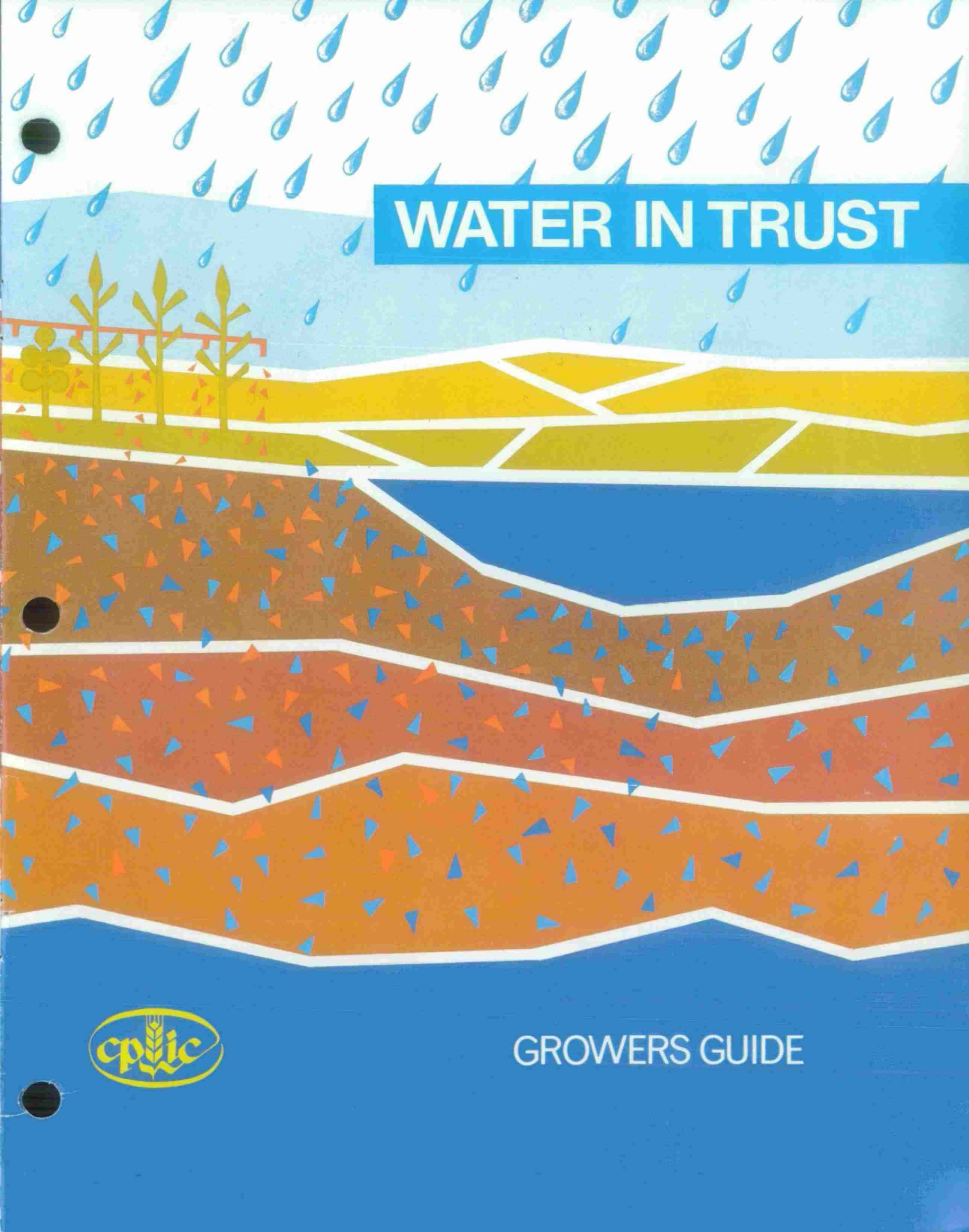
WATER IN TRUST
cplic
GROWERS GUIDE

L'EAU, SOURCE DE VIE

icepc

GUIDE DU PRODUCTEUR

A GROWER'S GUIDE

Our farm management decisions can reduce the level of crop protection chemicals (pesticides) moving from the land into public water supplies. [Soil erosion and fertilizer runoff also contribute to this contamination.]

this publication has been produced by CPIC Task Force on Crop Protection Chemicals in Water*

Ontario Ministry of Agriculture and Food: **R. Frank**, Guelph; **R.H. Brown**, Ridgetown.
Gouvernement du Québec, Ministère de l'Agriculture, des Pêcheries et de l'Alimentation: **P. Lavigne**, Québec City
Ontario Ministry of Environment: **D. Mewett**, Toronto
P. Moncrieff, Cyanamid; **Z. Talach**, Van Waters & Rogers; **T. Sawyer**, Ciba-Geigy

*Crop Protection Institute of Canada, 6 Lansing Sq., Willowdale, Ontario M2J 1T5

copies available from cpic $1.00 each, minimum order 25.

The CPIC Task Force appreciated input from the following:
Agriculture Canada
Environment Canada
Gouvernement du Québec, Ministère de l'Environnement
Conservation Council of Ontario
Canadian Environmental Law Assoc.
Mouvement Agriculture Biologique au Québec
The Pollution Probe Foundation

GUIDE DU PRODUCTEUR

Vos décisions en matière de gestion agricole peuvent réduire les quantités de produits antiparasitaires qui se déplacent du sol jusqu'aux sources d'approvisionnement d'eau. [L'érosion du sol et le ruissellement des engrais contribuent également à cette contamination.]

Cette publication a été produite par le groupe de travail de l'ICPC sur les produits antiparasitaires dans l'eau.*

Ministère de l'Agriculture et de l'Alimentation de l'Ontario: **R. Frank**, Guelph; **R.H. Brown**, Ridgetown
Gouvernement du Québec, Ministère de l'Agriculture, des Pêcheries et de l'Alimentation: **P. Lavigne**, Québec
Ministère de l'Environnement de l'Ontario: **D. Mewett**, Toronto **P. Moncrieff**, Cyanamid; **Z. Talach**, Van Waters & Rogers; **T. Sawyer**, Ciba-Geigy

*Institut canadien pour la protection des cultures, 6 Lansing Sq., Willowdale, Ontario M2J 1T5
On peut obtenir des exemplaires auprès de ICPC à raison de 1$ chacun, commande minimale de 25 exemplaires.

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Agriculture Canada
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Conservation Council of Ontario
Canadian Environmental Law Assoc.
Mouvement Agriculture Biologique au Québec
The Pollution Probe Foundation

Water supports all life. Some simple organisms can exist without air but none can grow without water. Water has remained unchanged in amount and character over millions of years. Because it's so common and ordinary, none of us gives much thought to water until it fails or endangers us.

Surface water abounds in the Great Lakes and St. Lawrence regions. Great use and abuse is made of it!

What you and I cannot see is the groundwater that lies beneath our feet. Out of sight is out of mind.

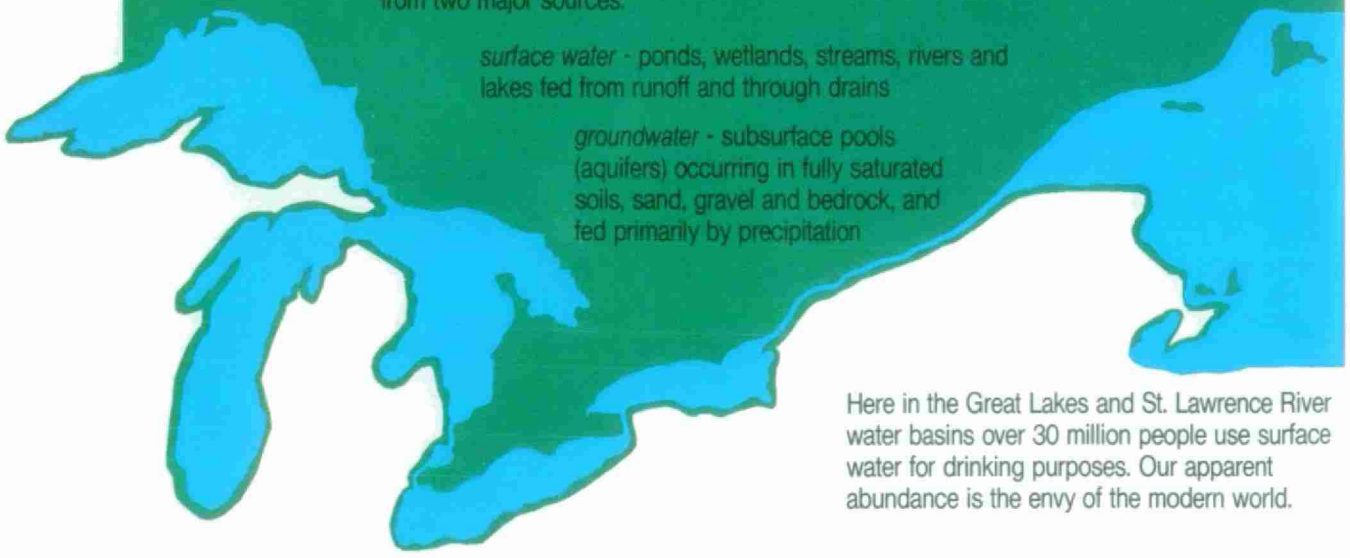
Crop protection chemicals have been detected in both groundwater and surface water and there is growing public concern.

As stewards of the land we must take responsibility for the water that runs off our soil and the water that filters through our soil because it's ... WATER IN TRUST!

Our supply of drinking water is a precious natural resource available from two major sources:

surface water - ponds, wetlands, streams, rivers and lakes fed from runoff and through drains

groundwater - subsurface pools (aquifers) occurring in fully saturated soils, sand, gravel and bedrock, and fed primarily by precipitation



Here in the Great Lakes and St. Lawrence River water basins over 30 million people use surface water for drinking purposes. Our apparent abundance is the envy of the modern world.

However the quality of our water resources is open to question! Spiralling increases in agricultural, household, industrial and municipal pollutants in the form of garbage, effluent, by-products and storm-water runoff from roads, parking lots and fields are triggering public demands for accountability.

L'eau
est essentielle
à toute forme de vie.
Certains organismes simples
peuvent exister sans air, mais
aucun ne peut se développer sans eau.
Le volume et la nature de l'eau sont
restés les mêmes depuis des millions
d'années. Parce que l'eau est si
commune et ordinaire, aucun de nous
n'y accorde d'attention sauf quand
elle vient à manquer ou
qu'elle met nos vies
en danger.

Dans
la région
des Grands Lacs
et la vallée
du Saint-Laurent il y a
abondance d'eau de surface.
Elle est utilisée en grande quantité
et même de manière abusive.

On ne peut cependant voir l'eau
souterraine qui coule sous nos pieds.
Et comme dit le proverbe:
"Loin des yeux, loin du coeur".

La présence de produits antiparasitaires
dans l'eau souterraine et
l'eau de surface préoccupe de
plus en plus le public.

Comme utilisateurs du sol, vous êtes responsables de l'eau qui ruisselle sur le sol et de celle qui s'y infiltre car c'est l'eau, SOURCE DE VIE!

L'eau potable constitue une précieuse ressource naturelle et provient de deux sources importantes:

l'eau de surface - étangs, marécages, rivières et lacs alimentés par les eaux de ruissellement et le déversement des drains;

l'eau souterraine: nappes aquifères situées dans les sols entièrement saturés (sable, gravier et roc), alimentées essentiellement par les précipitations.

Dans la région des Grands Lacs et la vallée du Saint-Laurent, plus de 30 millions de personnes utilisent l'eau de surface pour leur consommation. Cette abondance apparente fait l'envie du monde contemporain.

Toutefois, la qualité de l'eau est remise en question. L'augmentation rapide d'agents polluants, domestiques, industriels, municipaux et agricoles sous forme d'ordures, d'effluents, de sous-produits divers ainsi que de ruissellement provenant des routes, des terrains de stationnement et des champs incite le public à chercher des responsables.

4 AGRICULTURE AND THE BIG WATER PICTURE

crop production

There are approximately 114,000 farms in Ontario and Quebec. Forty thousand of us are row crop farmers, growing mostly corn and soybeans.

We're among the best at what we do. We contribute much to the food system and economy of Canada.

We also contribute ... through soil erosion ... fertilizer runoff ... and crop protection chemical movement, to the emerging problem of drinking water quality.

Twenty per cent of Canadian crop protection chemical sales are in Ontario and Quebec. Herbicides represent 75% and insecticides 12% of the $190 million spent annually.

agricultural contamination

The crop protection chemicals now being identified in surface water come mainly from the *erosion of soil*. Row crops are the chief contributors to soil erosion: 1,210,000 hectares (3 million acres) of corn land and 485,000 hectares (1,200,000 acres) of bean land.

Direct groundwater contamination is primarily due to *human error* at and around the farm well.

need for improvement

The food system needs crop protection chemicals, and other productivity advances, to improve competitiveness in the global marketplace.

Rights are granted by the public and rights can be taken away. As managers we must accept responsibility for our use of chemicals in the food system.

OUR IMMEDIATE, PERSONAL GOALS IN THE HANDLING AND APPLICATION OF CROP PROTECTION CHEMICALS MUST BE: ***FIRST*** ELIMINATE HUMAN ERROR; AND ***SECOND*** REDUCE PESTICIDE MOVEMENT TO SURFACE WATER BY 50%

4 L'AGRICULTURE ET L'EAU

la production végétale

Le Québec et l'Ontario compte environ 114 000 fermes. Les cultures en rangs, principalement maïs et soja, sont produits dans 40 000 d'entre elles.

Vous êtes parmi les meilleurs dans le domaine agricole. Votre contribution au système alimentaire et à l'économie du Canada est importante.

Toutefois, vos pratiques culturales contribuent au problème de la qualité de l'eau potable (érosion du sol, lessivage des engrais et entraînement des produits antiparasitaires).

Au Canada, 20% des ventes de produits antiparasitaires sont réalisées au Québec et en Ontario. Des 190 millions de dollars investis annuellement, les herbicides comptent pour 75% et les insecticides, pour 12%.

contamination agricole

C'est essentiellement *l'érosion du sol* qui est à l'origine de la présence de produits antiparasitaires dans l'eau de surface. Les cultures en rangs sont le principal facteur d'érosion du sol: 1 210 000 hectares (3 000 000 d'acres) en maïs et 485 000 hectares (1 200 000 acres) en soja et haricots.

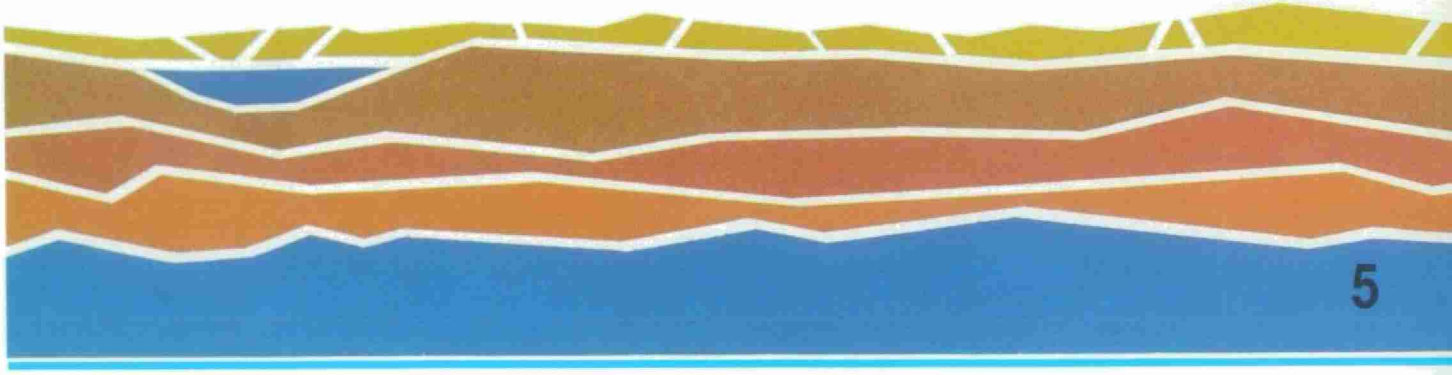
L'erreur humaine à proximité d'un puits de ferme est la principale cause de la contamination directe de l'eau.

besoin d'amélioration

Les techniques modernes de productivité, dont les produits antiparasitaires, sont nécessaires pour améliorer la compétitivité de l'industrie agro-alimentaire.

En tant que gestionnaires agricoles, vous avez des droits mais vous devez également assumer, vis-à-vis de la société, la responsabilité de votre emploi des produits antiparasitaires dans l'industrie agro-alimentaire.

VOS OBJECTIFS PERSONNELS IMMÉDIATS CONSISTENT *D'ABORD* À ÉLIMINER L'ERREUR HUMAINE, *PUIS* À RÉDUIRE DE 50% LE DÉPLACEMENT DES PESTICIDES VERS L'EAU DE SURFACE PAR LA MANUTENTION ET L'APPLICATION SÉCURITAIRES ET RESPONSABLES DES PRODUITS ANTIPARASITAIRES.



The water that falls on our land is not ours, it's ***water in trust***.

WHAT HAPPENS TO WATER WHEN IT FALLS ON OUR CROP LAND?*

evaporates or transpires from plants	66%
runs off soil surface into ponds, streams and rivers	25%
enters & moves down through soil to groundwater	9%

** Varies by soil type and crop*

average annual precipitation as snow/rain

Harrow	68cm (27")
Kitchener	98cm (36")
Montreal	106cm (39")

method of movement of persistent crop protection chemical into surface water*

storm runoff	50 - 60%
tile drains	16 - 25%
human error	18 - 25%

** Lasting longer than 10 weeks in soil.*

*seasonal influence on movement of persistent crop protection chemicals into surface water**

Jan., Feb., Mar., Apr. [high precip/snow melt]	54%
May, June, July, Aug. [pesticide use season]	32%
Sept., Oct., Nov., Dec.	14%

** 15 years of detailed atrazine observations.*

examples of crop protection chemicals persistence in soil

lesser <persistence> greater

butylate
cyanazine
diazinon
dicamba
dichlorprop
EPTC
malathion
2,4-D
alachlor
metolachlor
aldicarb*
atrazine
simazine
trifluralin

loss to surface water

0.002% <range> 1.8%

** Insecticide appearing in groundwater in certain potato growing areas.*

Vous n'êtes pas propriétaire de l'eau qui tombe sur vos fermes: c'est ***l'eau, source de vie***.

QU'ADVIENT-IL DE L'EAU QUI TOMBE SUR NOS CULTURES?*

Elle s'évapore ou est transpirée par les plantes. 66 %

Elle ruisselle sur le sol jusqu'aux étangs, ruisseaux et rivières. 25 %

Elle s'infiltre dans le sol jusqu'à l'eau souterraine. 9 %

*Varie selon le type de sol et la culture.

Précipitations annuelles moyennes sous forme de pluie ou de neige

Harrow, Ont. 68 cm (27 po)

Kitchener, Ont. 98 cm (36 po)

Montréal, Québec 106 cm (39 po)

Facteurs de déplacement des produits antiparasitaires persistants vers les eaux de surface*

ruissellement 50 à 60%

drainage souterrain 16 à 25%

erreur humaine 18 à 25%

*Qui prend plus de 10 semaines à se dégrader dans le sol.

*Influence des saisons sur le déplacement vers les eaux de surface des produits antiparasitaires persistants**

janv., fév., mars, avril 54%
[précipitations élevées/fonte des neiges]

mai, juin, juil., août 32%
[saison d'utilisation des pesticides]

sept., oct., nov., déc. 14%

*Basé sur 15 ans d'observations détaillées de l'atrazine

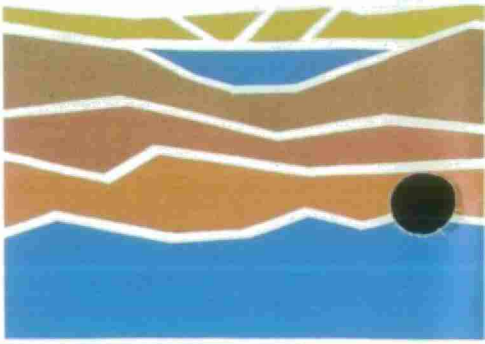
Exemples de persistance de produits antiparasitaires dans le sol

Moins persistant	persistant	plus persistant
butylate	alachlore	
cyanazine		atrazine
diazinon		
dicamba		
dichlorprop		
EPTC	métolachlore	
malathion		
2,4-D		simazine
	aldicarbe*	trifluraline

% d'écoulement vers les eaux de surface

0,002% <échelle> 1,8%

*Insecticide apparaissant dans l'eau souterraine de certaines régions de culture des pommes de terre



6 SOIL MANAGEMENT FOR WATER QUALITY

Primary food production is an $8 billion annual business in Ontario and Quebec, 40% of the Canadian total.

Be proud ... productivity gains in agriculture are the largest of all industries over the past 25 years.

Be upset ... the price for our increased productivity may be degradation of our soil resources.

Be concerned ... when soil erodes from our farms it takes with it our productive base and costly inputs of fertilizer and crop protection chemicals.

Be warned ... the public regards all chemicals as dangerous and is in a mood to deal with the contaminators of its drinking water!

OUR GOAL MUST BE TO KEEP EVERYTHING IN ITS PLACE, STARTING WITH THE SOIL.

*atrazine loss to surface water**

clay	1.8%
loam	0.6%
sand	0.3%

** 1975-77 data from 10 agricultural watersheds*

WHAT DO YOU KNOW ABOUT YOUR SOIL?

• ***texture*** - relative proportion of sand, silt and clay.

Fine textured (clay) soils slow water movement downward but are larger contributors to runoff and potential surface water contamination.

Coarse textured (sandy) soils offer less resistance to water moving downward which increases the risk of groundwater contamination.

Crop protection chemicals tend to adhere (be adsorbed) to clay.

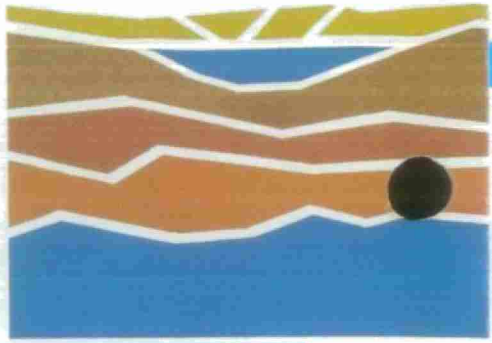
• ***permeability*** - general measure of how fast water can move downward in a particular soil.

The more permeable (sandy) soils must be carefully managed to prevent crop protection chemical movement to groundwater.

• ***organic matter*** - influences how much water the soil can hold before water movement occurs.

Increasing the amount of organic matter decreases water movement and reduces the movement of crop protection chemicals to groundwater and surface water.

Some crop protection chemicals are adsorbed onto organic matter. Linuron, for example, may be used safely in beans and potatoes where the soil has 2 to 3% organic matter. It may cause crop damage if organic matter is under 2%. The coarser the soil the more severe the crop damage.



6 GESTION DU SOL: QUALITÉ DE L'EAU

La production des denrées agricoles génère un chiffre d'affaires annuel de 8 milliards de dollars au Québec et en Ontario, soit 40% de la production canadienne.

Soyez fiers!... Au cours des 25 dernières années, de toutes les industries, c'est l'agriculture qui a réalisé les gains de productivité les plus importants.

Soyez préoccupés!... Le prix à payer pour cette productivité accrue peut être la dégradation de vos sols.

Soyez inquiets!... Lorsque le sol s'érode de vos fermes, il emporte avec lui votre ressource principale, vos intrants coûteux d'engrais et vos produits antiparasitaires.

Soyez avertis!... La société considère tous les produits antiparasitaires comme dangereux et n'est pas d'humeur à plaisanter avec ceux qui contaminent l'eau potable.

NOTRE OBJECTIF DOIT CONSISTER À LAISSER CHAQUE CHOSE À SA PLACE, À COMMENCER PAR LE SOL.

*Perte d'atrazine dans les eaux de surface**

argile	1,8%
loam	0,6%
sable	0,3%

*Données relevées entre 1975 et 1977 provenant de 10 bassins agricoles

QUE SAVEZ-VOUS DE VOTRE SOL?

•***Texture:*** proportion relative de sable, de limon et d'argile.

Dans les sols à texture fine (argileux), le mouvement d'infiltration de l'eau est lent, ce qui contribue dans une large mesure au ruissellement et à la contamination possible des eaux de surface. Par contre, les produits antiparasitaires tendent à se fixer à l'argile; on dit alors qu'ils sont adsorbés.

Dans les sols à texture grossière (sablonneux) cependant, la résistance à l'infiltration de l'eau est moindre, ce qui augmente le risque de contamination de l'eau souterraine.

• ***Perméabilité:*** propriété d'un sol à permettre l'infiltration de l'eau plus ou moins rapidement.

Les sols plus perméables (sablonneux) doivent être gérés avec soin afin de prévenir l'infiltration de produits antiparasitaires jusqu'à l'eau souterraine.

• ***Matière organique***: composante du sol qui influe sur la quantité d'eau que le sol peut retenir avant qu'il n'y ait infiltration.

Toute augmentation de la quantité de matière organique diminue le déplacement de l'eau et réduit le déplacement des produits antiparasitaires vers l'eau souterraine et les eaux de surface.

Certains produits antiparasitaires sont adsorbés par la matière organique. Le linuron, par exemple, peut être appliqué sans risque sur les haricots et les pommes de terre là où le sol a une concentration de 2 ou 3% de matière organique. Il peut causer des dommages à la culture si le niveau de matière organique se situe en deçà de 2%. Plus le sol est grossier, plus les dommages causés à la culture risquent d'être importants.

HOW CAN YOU IMPROVE YOUR SOIL MANAGEMENT?

- green manure crop - red clover or forage in rotation to increase organic matter, improve soil structure, increase water holding capacity

- apply livestock manure - for same reasons

- trash - leave a 30% trash cover on a rough soil surface

- soil compaction - bigger machines cause more compaction hence more runoff. Avoid tilling soils high in moisture. Limit tillage to topsoil layer.

- slopes - work across the slope or use strip cropping, grassed waterways or buffer zones where slopes are long or steep

- crop selection - utilize fall cover crops or winter cereals where possible and practical

- tillage - utilize equipment that maximizes soil conservation and trash cover.

WHAT ARE THE PHYSICAL PROPERTIES OF YOUR CROP PROTECTION CHEMICALS?

- ***leaching factor*** - interaction between chemical and soil properties, modified by amount of water passing through soil.

- ***soil adsorption*** - some chemicals become tightly attached (strongly adsorbed) and won't move in the soil or soil water. [eg. paraquat, diquat] Others do not. Adsorption is improved by increasing organic matter.

- ***persistence*** - persistent chemicals take a long time to break down. They are more likely to reach water over time. (eg. atrazine, simazine)

Conversely, aldicarb, which is not persistent in soil, may move through sandy soils to groundwater. Therefore recommended management on sandy soils is to increase organic matter and only use the chemical every second year.

FAÇONS D'AMÉLIORER LA GESTION DE VOTRE SOL

• Cultivez un engrais vert pour augmenter la quantité de matière organique, améliorer la structure du sol, accroître la capacité de rétention en eau du sol.

• Appliquez du fumier, pour les mêmes raisons.

• Résidus de culture: laissez 30% de résidus sur les sols grossiers.

• Tassement du sol: restreindre le passage répété de la machinerie lourde; évitez de travailler les sols très humides; limitez le labour à la couche arable.

• Pentes: travaillez la terre perpendiculairement à la pente ou pratiquez les cultures en bandes alternées, gazonnez les bords des voies d'eau ou prévoyez des zones tampon lorsque les pentes sont longues ou accentuées.

• Choix des cultures: utilisez un système de cultures qui laisse le sol à découvert le moins longtemps possible.

• Labour: utilisez l'équipement qui maximise la conservation du sol et la couche de résidus.

QUELLES SONT LES PROPRIÉTÉS PHYSIQUES DE VOS PRODUITS ANTIPARASITAIRES?

• ***Indice de lessivage:*** résultat de l'interaction entre les propriétés du produit antiparasitaire et celles du sol, influencé par la quantité d'eau s'infiltrant dans le sol.

• ***Pouvoir d'adsorption du sol:*** certains produits antiparasitaires se fixent énergiquement (forte adsorption) et ne sont pas entraînés par l'eau du sol [ex.: paraquat, diquat]. D'autres le sont moins. On améliore l'adsorption de certains produits en augmentant la quantité de matière organique.

• ***Persistance:*** les produits antiparasitaires persistants se dégradent lentement et risquent plus d'atteindre l'eau au bout d'un certain temps (atrazine, simazine).

À l'opposé, l'aldicarbe, qui n'est pas aussi persistant dans le sol, peut s'infiltrer dans les sols sablonneux jusqu'à l'eau souterraine. Par conséquent, la régie recommandée pour les sols sablonneux est d'augmenter la matière organique et de n'utiliser le produit antiparasitaire que tous les deux ans.

8 CROP PROTECTION CHEMICALS MANAGEMENT FOR WATER QUALITY

ARE YOU USING YOUR CROP PROTECTION CHEMICALS RESPONSIBLY?

PLANNING

• Mark problem areas of weeds, insects and diseases on a map of premeasured fields during growing and harvest period.

Review and study your alternatives to determine if crop protection chemicals are a solution to your problem.

• Select control methods by
1) field, 2) crop, 3) problem, and 4) timing.

• Study the products available by contacting specialists, attending educational meetings, reading labels and discussing requirements early with dealers.

• Take special care with flood-prone cropland by using only less persistent products.

• On clay soils prone to surface runoff use preplant incorporated products if possible.

STORAGE

Common sense is the first order of storage.

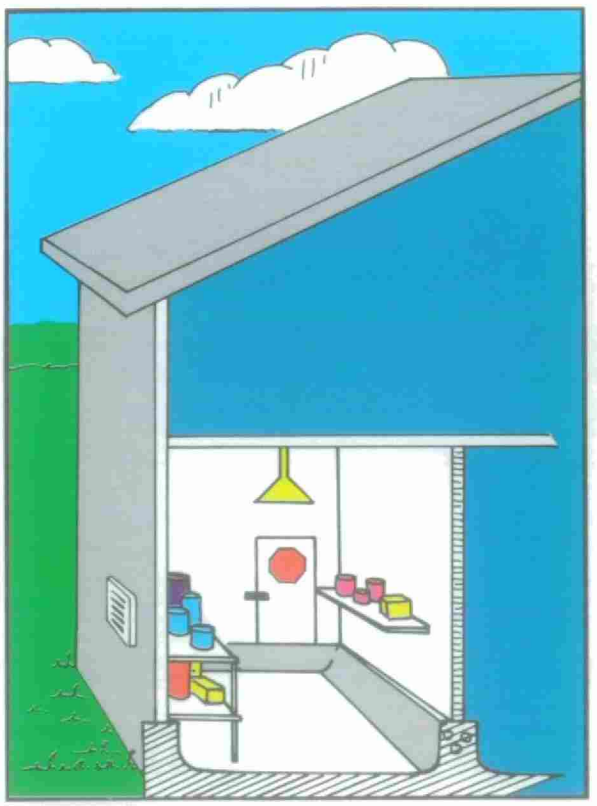
• Use a separate room or building away from humans, livestock, feed, produce and clothing.

• Area should be dry, heated and insulated, well ventilated, locked and signed: "WARNING - CHEMICAL STORAGE"

• Location must:
- be a minimum of 50 metres (150') from water source
- have water-holding floor and lip to contain spills
- have level drainage in exterior area

• Crop protection chemicals must be used within two to three years of purchase.

• In Ontario, the Ontario Ministry of Agriculture and Food and the Ontario Ministry of the Environment have a grant program for storage and handling facilities for crop protection chemicals on the farm.



SPRAYER EQUIPMENT

The most important factor in spraying is the operator.

Sprayers are a relatively low investment when compared to land, buildings, other machinery and crop input costs.

8 GESTION DES PRODUITS ANTIPARASITAIRES: QUALITÉ DE L'EAU

UTILISEZ-VOUS VOS PRODUITS ANTIPARASITAIRES DE MANIÈRE RATIONNELLE?

PLANIFICATION

• Intégrez les mesures de protection des cultures dans le cadre d'un programme général de production.

• Faites un plan des champs et indiquez les endroits infestés par les mauvaises herbes et ceux où vous remarquez des problèmes d'insectes ou de maladies, lors d'inspections régulières dans vos cultures ou au moment de la récolte.

Passez en revue et analysez les solutions de rechange afin de déterminer si les produits antiparasitaires peuvent résoudre votre problème.

• *Sélectionnez les méthodes de protection selon 1) le champ, 2) la culture, 3) le problème rencontré et 4) la période d'application.*

• Étudiez les produits offerts en communiquant avec des spécialistes, en assistant à des réunions d'information, en lisant les étiquettes et en discutant tôt de vos besoins avec les détaillants.

• Accordez une attention particulière aux terres sujettes aux inondations en n'y appliquant que des produits moins persistants.

• Sur les sols argileux sujets au ruissellement, incorporez des produits en présemis, si possible.

ENTREPOSAGE

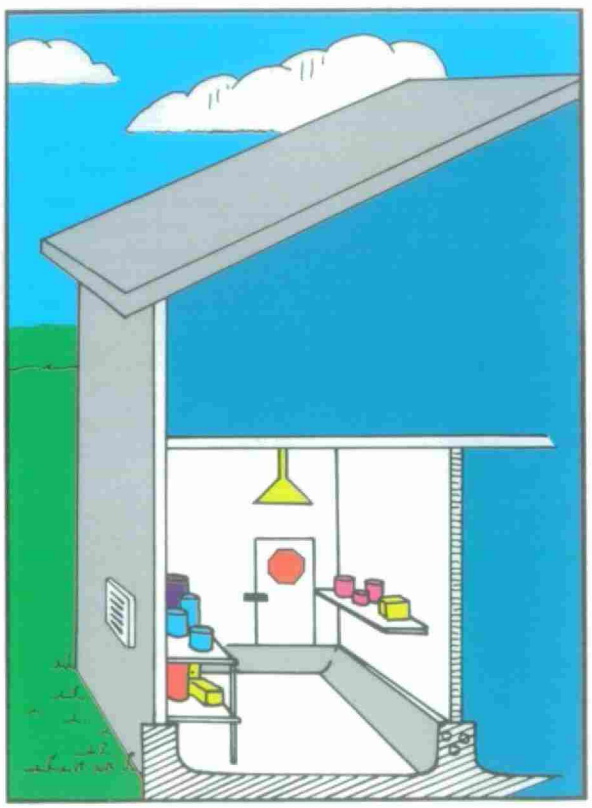
La première règle en entreposage consiste à faire preuve de bon sens.

• Utilisez une pièce ou un bâtiment séparé, à l'écart des personnes, du bétail, de la nourriture de consommation humaine et animale et des vêtements.

• L'endroit choisi doit être sec, chauffé et isolé, bien aéré, verrouillé et identifié comme suit: "ATTENTION - ENTREPOSAGE DE PRODUITS ANTIPARASITAIRES".

• Cet endroit doit
- se situer à au moins 50 mètres (150 pi) d'un point d'eau;
- avoir un plancher étanche muni d'un rebord pour contenir les déversements;
- comporter une surface de drainage extérieure, située au même niveau que le plancher.

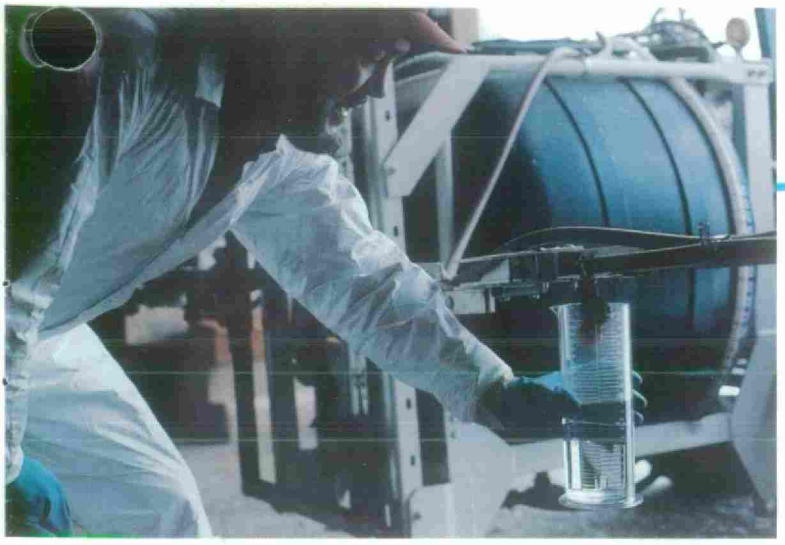
• Les produits antiparasitaires doivent être utilisés dans les deux ou trois ans suivant l'achat.



• En Ontario, le ministère de l'Agriculture et de l'Alimentation et le ministère de l'Environnement de l'Ontario offrent un programme de subventions à l'intention des producteurs souhaitant mettre en place des installations d'entreposage et de manutention de produits antiparasitaires sur leur ferme.

ÉQUIPEMENT DE PULVÉRISATION

L'opérateur est l'élément le plus important lors des pulvérisations.



We must eliminate spills and carelessness around farm wells and other water sources immediately.

Build a slope of impervious clay material running away from the well for seven metres (20').

Inspect older wells for the condition of upper two to three metres (6 to 10 feet) of casing and the top. Replace the casing and cap with new concrete if questionable.

A preventive maintenance program for our sprayers is essential. Three to 5% of the value of annual pesticide purchases should be budgeted towards maintaining and upgrading our sprayers.

Calibrate the sprayer tank and mark volume increments.

Filter and screen all water and chemicals entering the sprayer. Plan to keep all foreign objects out of the sprayer system.

Calibrate and re-calibrate the sprayer several times during the spraying season. Record pressure, volume and speed after each re-calibration.

OPERATOR CARE

18 to 25 % of persistent crop protection chemical movement into water is due to spills and carelessness.

WATER FOR SPRAYING

Develop an efficient filling and mixing procedure which provides you and the environment with maximum safety.

Never mix or load a sprayer within 50 metres (150') of the water source. [Refer to OMAF grant provisions]

Use a water wagon for maximum control. Take it to the sprayer in the field for maximum efficiency.

Use a foot valve/anti-backflow device when drawing water.

Holding tanks must be 50 metres (150') from the water source.

Les pulvérisateurs représentent un investissement peu élevé proportionnellement au prix de la terre, des bâtiments, des autres pièces d'équipement et des intrants.

Il est essentiel d'appliquer un programme d'entretien préventif des pulvérisateurs. En fait, il convient de consacrer 3 à 5% de la valeur des achat annuels de pesticides à l'entretien et à l'amélioration des pulvérisateurs.

Calibrez et graduez le réservoir du pulvérisateur.

Filtrez l'eau et faites en sorte que les corps étrangers restent en dehors du système de pulvérisation.

Calibrez et recalibrez le pulvérisateur plusieurs fois au cours de la saison de pulvérisation. Notez la pression, le volume et la vitesse après chaque calibrage.

OPÉRATEURS — PRÉCAUTIONS À PRENDRE

Les déversements accidentels et la négligence sont causes de 18 à 25% des cas de contamination de l'eau par les produits antiparasitaires.

Il faut à tout prix éliminer dès maintenant les déversements et le manque d'attention à proximité des puits de ferme et des autres sources d'eau.

Construisez un plan d'égouttement en pente, fait d'un matériau argileux imperméable, jusqu'à sept mètres du puits (20 pi).

Inspectez les vieux puits pour déterminer l'état des deux ou trois premiers mètres (6 à 10 pi) de paroi et du couvercle. Au besoin, remplacez la paroi et le couvercle avec du nouveau béton.

EAU DE PULVÉRISATION

Utilisez une méthode efficace de remplissage et de mélange qui assure un maximum de sécurité, tant pour vous que pour l'environnement.

Ne faites jamais de mélange et ne remplissez jamais un pulvérisateur à moins de 50 mètres (150 pi) d'un point d'eau. [Consulter les conditions d'admissibilité aux subventions du ministère de l'Agriculture et de l'Alimentation de l'Ontario]

Utilisez un réservoir d'eau mobile pour plus de sécurité et de contrôle et apportez-le au champ.

Pour pomper l'eau, utilisez un dispositif à soupape d'aspiration anti-refoulement.

Les réservoirs (eau ou pesticide en vrac) doivent se trouver à au moins 50 mètres (150 pi) du point d'eau.

CHEMICALS FOR SPRAYING

Never handle or mix chemicals with bare skin exposed!

Always wear neoprene or nitrile gloves. Greater than 70% of dermal exposure is through the hands!

Follow the label directions for the use of goggles, face masks and protective clothing.

Triple or pressure rinse containers. Add the rinse water to the sprayer tank. Up to 4% of the product may remain in an unrinsed 10L container, worth from $2 to $10. The second and third rinsing is done for our safety and the environment!

Record the product, volume, location and date of application for each field.

APPLICATION

Use common sense

Do not spray within 15 metres (50') of the well.

Observe a setback of 3 metres (10') from all open water sources: ditches, ponds and creeks.

Plan ahead and mix the correct amount for the precise area to be sprayed.

Apply any leftover solution to the sprayed area, considering residues and crop.

Wash the sprayer, inside and out, in an area where the wash water can be safely degraded in the soil (away from drains, wells and other water sources).

SPILLS CLEANUP

Accidents do happen at spraying time.

Quick action is essential to reduce the impact on the handler and the environment.

Spills anywhere must be kept from moving to potential water sources. Use soil, straw or other absorbent material immediately and then remove contaminants and spread on labelled crop area.

If a chemical is accidently put into a well, prompt pumping is absolutely necessary. Contact a specialist for advice on how to cleanse the system which may involve irrigating at least 50 metres from the well.

For spill cleanup advice consult with the dealer, local government experts or the manufacturer of the product.

Canadian Transport Emergency Centre
CANUTEC 1-613-996-6666

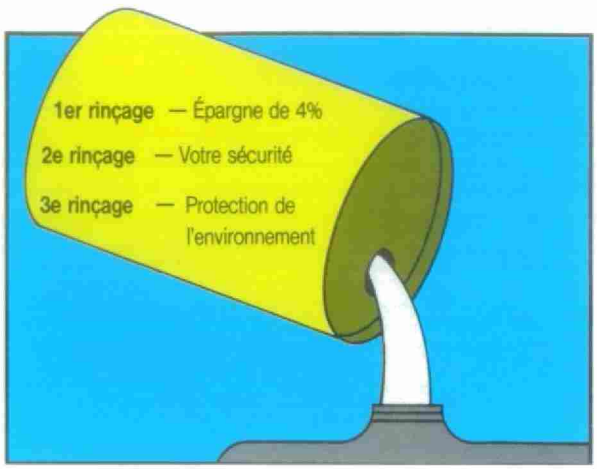
Major spills in Ontario: (Toll Free)
SPILLS ACTION CENTRE 1-800-268-6060

Quebec
daytime: local office of
Ministere de l'Environnement
evening: 418-643-4595 or 514-873-3454

PRODUITS ANTIPARASITAIRES

Il ne faut jamais manipuler ni mélanger des produits antiparasitaires en laissant certaines parties du corps à découvert.

Portez toujours des gants de néoprène ou de nitrile. Plus de 70% des absorptions cutanées se font par les mains.



Suivez les directives de l'étiquette quant à l'utilisation de lunettes de protection, de masques et de vêtements protecteurs.

Rincez les contenants trois fois ou sous pression. Versez l'eau de rinçage dans le réservoir du pulvérisateur. Il peut rester jusqu'à 4% de produit dans un contenant de 10L non rincé, soit 2 à 10$ de produit. Procédez au triple rinçage à des fins de sécurité pour soi-même et pour l'environnement et par souci d'économie.

Notez le volume, l'endroit et la date d'application du produit pour chaque champ.

APPLICATION

Faites preuve de bon sens

Laissez une bande de 15 mètres (50 pi) autour d'un puits.

Laissez une zone non traitée de 3 mètres (10 pi) à proximité de tous points d'eau: fossés, étangs et ruisseaux.

Soyez prévoyant et mélangez la quantité exacte à pulvériser sur une surface donnée.

Appliquez tout surplus de bouillie sur la surface traitée, en tenant compte des résidus et de la culture.

Nettoyez le pulvérisateur, à l'intérieur et à l'extérieur, à un endroit où les résidus de l'eau de lavage peuvent se dégrader sans danger dans le sol (loin des drains, des puits et autres points d'eau).

NETTOYAGE DES DÉVERSEMENTS

Des accidents surviennent parfois au moment de la pulvérisation.

Il faut alors agir vite pour minimiser l'impact sur l'opérateur et l'environnement.

Il faut empêcher les matières déversées, où qu'elles soient, de se déplacer vers des points d'eau. Utilisez de la terre, de la paille ou tout autre matériau absorbant immédiatement, puis ramassez le matériau contaminé et si possible répandez-le sur des surfaces qui peuvent recevoir des cultures prévues sur l'étiquette du produit.

Si un produit chimique est déversé accidentellement dans un puits, il faut absolument pomper l'eau sans tarder. Communiquez avec un spécialiste pour avoir des recommandations sur la façon de nettoyer le système, ce qui peut notamment inclure l'irrigation d'un rayon d'au moins 50 mètres autour du puits.

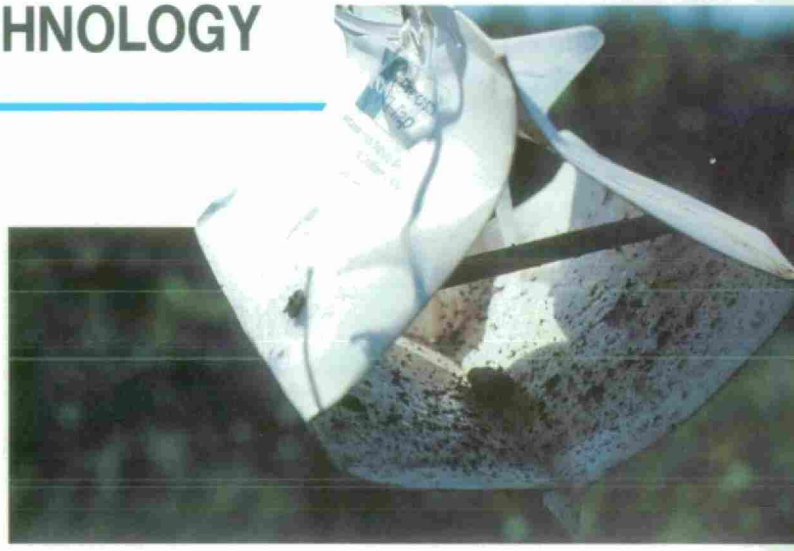
Pour nettoyer un déversement, consultez votre détaillant, les spécialistes gouvernementaux de votre région ou le fabricant du produit.

CANUTEC 1-613-996-6666

En Ontario (sans frais)
CENTRE D'INTERVENTION EN CAS DE DÉVERSEMENTS 1-800-268-6060

Au Québec -
le jour: bureau régional du Ministère de l'Environnement
après les heures ouvrables: 418-643-4595
514-873-3454

RESPONSIBLE GROWERS KEEP INFORMED ON NEW PEST MANAGEMENT TECHNOLOGY



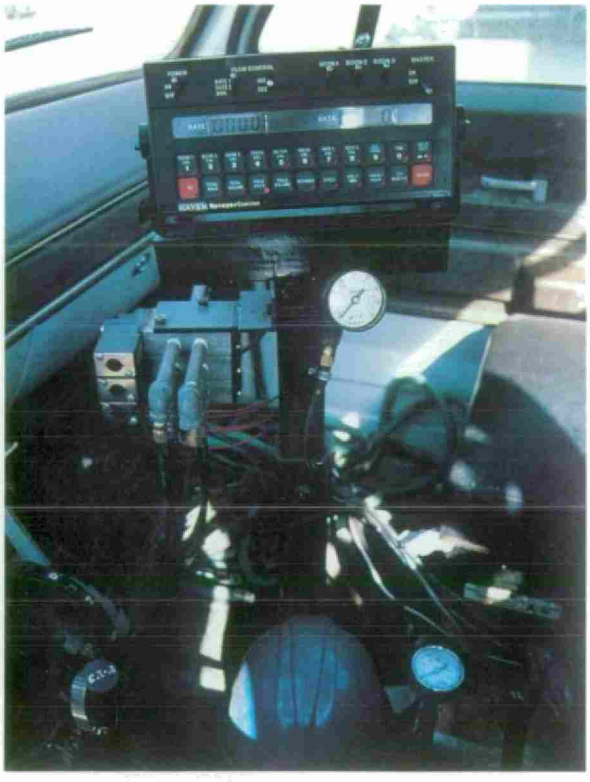
integrated pest management

Chemical usage can be reduced significantly by using ... crop rotations to avoid pest population buildup ... tillage practices to improve soil conditions ... pest-resistant varieties ...careful monitoring to ensure that chemical methods are used only when needed.

tile drainage

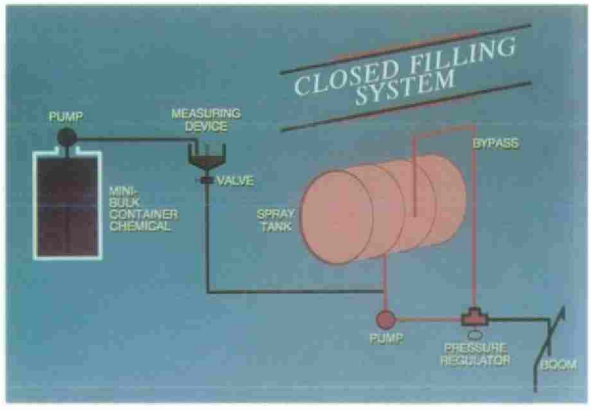
Tile drains, by reducing the volume of surface water runoff, reduce the amount of chemicals reaching public surface water sources.

Row crops grown on soils that crack should be given a shallow cultivation to prevent water and chemical flowing directly from surface down to tiles.



• ***spray monitors*** - will not replace operator judgement but are important management tools.

• ***direct injection sprayer*** - desirable advantages of eliminating pesticides from water solution, compatibility problems in tank mix and left-over spray solutions. Also allows more flexible application rates on target weeds, insects and diseases.

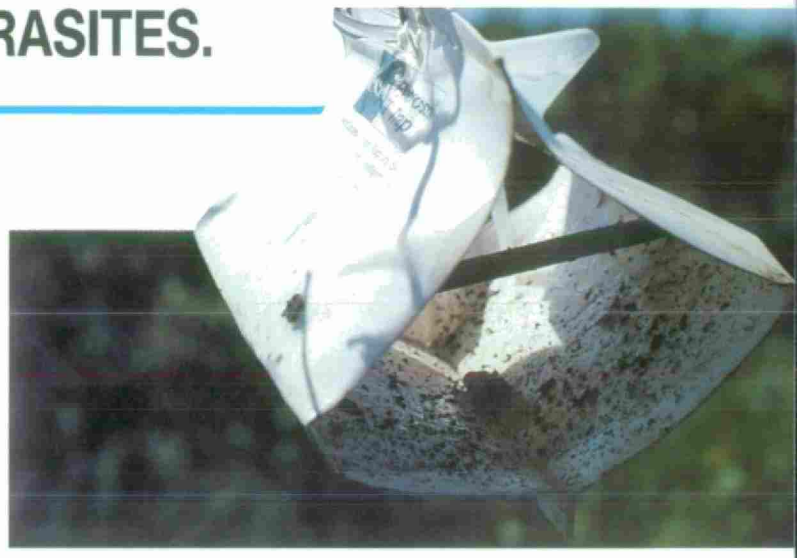


• ***closed system sprayer*** - reduce operator exposure to concentrated chemicals by transferring product directly from sale container into sprayer tank.

local weather

Use local weather forecasts with their predictions on probability and amount of rain to help schedule our spraying programs for maximum crop protection and minimum effect upon the environment.

LES PRODUCTEURS RESPONSABLES SE TIENNENT AU FAIT DE TOUTE NOUVELLE TECHNOLOGIE EN MATIÈRE DE RÉPRESSION DES PARASITES.

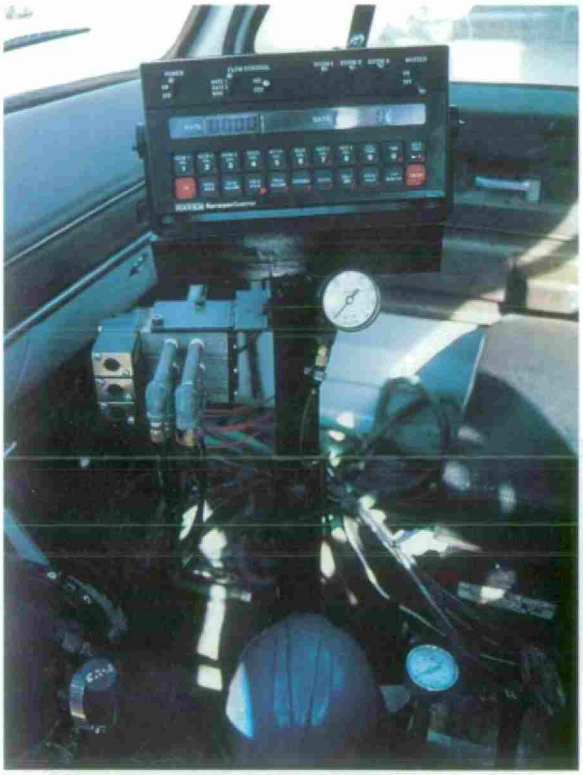


Lutte intégrée contres les parasites

Il existe des moyens de réduire sensiblement l'utilisation de produits antiparasitaires: rotation des cultures pour éviter l'augmentation de populations de parasites, façons culturales pour améliorer le sol, utilisation de cultivars résistant aux parasites, dépistage destiné à n'utiliser les produits antiparasitaires que lorsque la situation l'exige.

Drainage souterrain

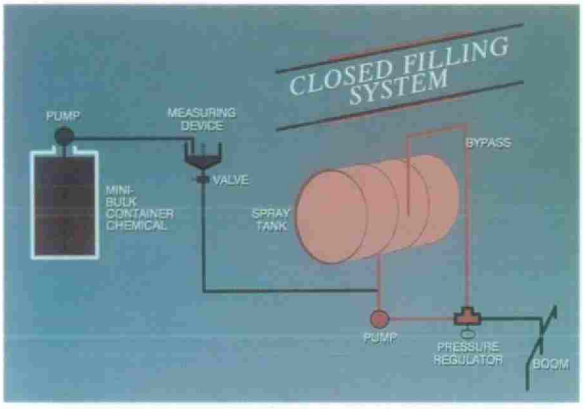
En réduisant le volume de ruissellement de l'eau, le drainage souterrain réduit la quantité de produits antiparasitaires qui atteint les sources d'approvisionnement d'eau.



Pour les cultures en rangs pratiquées sur des sols qui se fendillent, un léger hersage s'impose pour empêcher l'eau et le produit antiparasitaire d'atteindre les tuyaux de drainage.

• ***Dispositifs de contrôle de pulvérisation:*** ne remplacent pas le bon sens de l'opérateur mais restent d'importants outils de gestion.

• ***Pulvérisateur à injection directe:*** offre l'avantage d'éliminer la préparation de bouillie, les problèmes de compatibilité des produits dans le réservoir et les surplus de bouillie. Permet également une plus grande souplesse d'application des produits antiparasitaires.



• ***Pulvérisateur à circuit fermé:*** réduit l'exposition de l'opérateur aux produits concentrés en transférant le produit directement du contenant dans le réservoir du pulvérisateur.

Température locale

Connaître les prévisions météorologiques locales relativement aux risques et à l'intensité des averses prévues pour la planification des opérations de pulvérisation, afin de favoriser une protection maximale des cultures et de minimiser les effets sur l'environnement.

WATER IN TRUST

Crop protection chemicals can move from land to water!

Crop protection chemicals are valuable tools in the production of food but they must not be allowed to degrade our water quality. Prevention is always the wiser and less expensive course of action.

We who use crop protection chemicals must develop management strategies to avoid or minimize the loss of such chemicals into the public water system.

The water that falls on our land is not ours, it's ***water in trust***.

OUR IMMEDIATE, PERSONAL GOALS IN THE HANDLING AND APPLICATION OF CROP PROTECTION CHEMICALS MUST BE: ***FIRST*** ELIMINATE HUMAN ERROR; AND ***SECOND*** REDUCE PESTICIDE MOVEMENT TO SURFACE WATER BY 50%

We are stewards of our land, responsible for the water that runs off our soil and the water that runs through our soil because it's WATER IN TRUST.

CPIC thanks the following organizations for their input and financial support:

Soya-Bean Growers' Marketing Board
Ontario Corn Producers' Association
Ontario Soil and Crop Improvement Association

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SWEEP Program, Ag Can & Provinces

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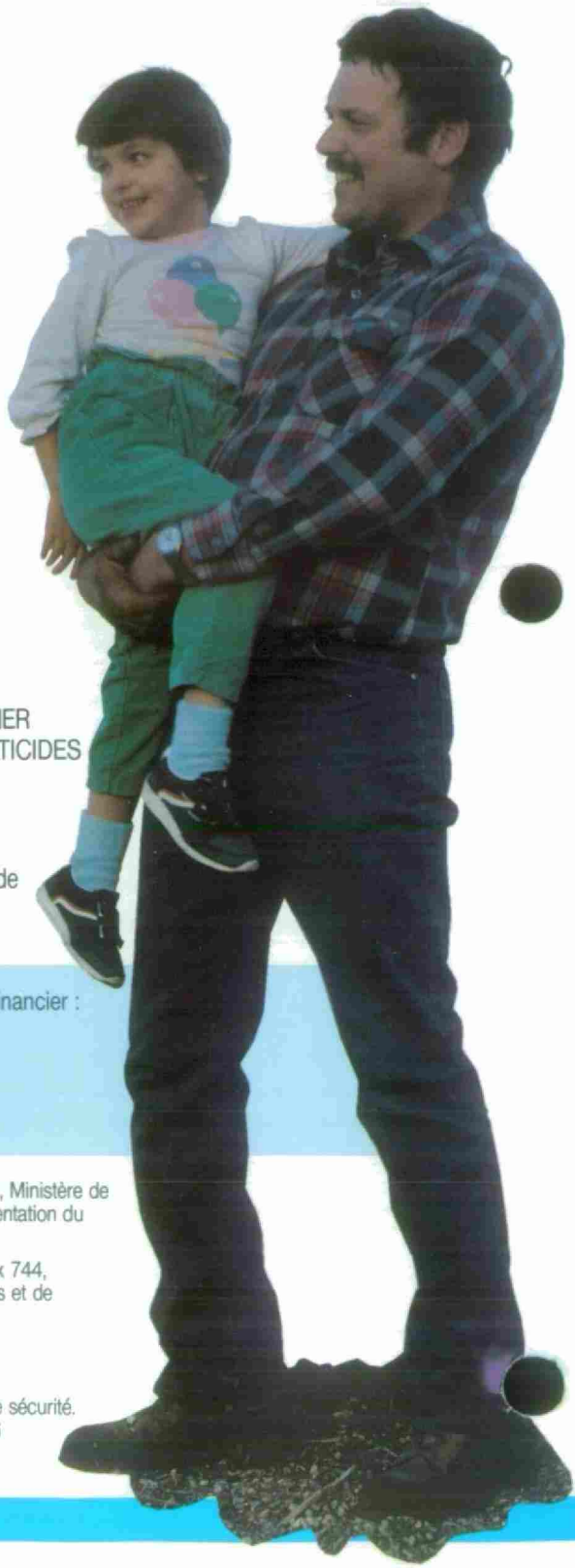
12 L'EAU, SOURCE DE VIE

Vous n'êtes pas propriétaire de l'eau qui tombe sur vos fermes: c'est *l'eau, source de vie.*

Les produits antiparasitaires sont des outils valables pour la production alimentaire mais il ne faut pas qu'ils puissent altérer la qualité de notre eau. La prévention constitue toujours le moyen d'action le plus sage et le moins onéreux qui soit.

Vous qui utilisez des produits antiparasitaires devez établir des stratégies de gestion destinées à minimiser la présence de ces produits dans les sources d'approvisionnement d'eau.



Les produits antiparasitaires peuvent se déplacer du sol vers l'eau.

VOS OBJECTIFS PERSONNELS IMMÉDIATS CONSISTENT *D'ABORD* À ÉLIMINER L'ERREUR HUMAINE, *PUIS* À RÉDUIRE DE 50% LE DÉPLACEMENT DES PESTICIDES VERS L'EAU DE SURFACE PAR LA MANUTENTION ET L'APPLICATION SÉCURITAIRES ET RESPONSABLES DES PRODUITS ANTIPARASITAIRES.

Vous êtes les utilisateurs du sol, responsables de l'eau qui ruisselle sur le sol et de celle qui s'y infiltre car c'est L'EAU, SOURCE DE VIE!

L'ICPC remercie les organismes suivants de leur apport et de leur appui financier :

Soya-Bean Growers' Marketing Board
Ontario Corn Producers' Association
L'Association pour l'amélioration des sols et récoltes de l'Ontario

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